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JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION

POPULATION CENSUSES BEFORE 1790

By A. B. Wolfe, *Ohio State University*

A population census, in the correct and specific sense, is a direct enumeration, preferably on a set date and by name of each individual in the census area. A census so made is both enumerative and "nominal." In most countries regularly recurring enumerative and nominal censuses are of comparatively recent origin. Before 1861 the number of European countries which had such censuses could be counted on the fingers of one hand. It is commonly thought that the idea, as well as the execution, of an enumerative census was started by the United States in 1790. The truth is that the idea of a complete enumerative population census was then by no means novel. The federal census of 1790 was preceded by various colonial censuses; the first Canadian census was taken in 1666; from 1749 on there was in Sweden a continuous registration system, which, while not an enumerative census, was a fair substitute; and certain Italian states had enumerative and nominal censuses as early as the sixteenth century.

While the term census should be confined specifically to complete nominal enumerations, it is frequently used in a more generic sense, covering also partial enumerations, of heads of families, hearths, male citizens of military age, etc. With the exceptions above noted, the "censuses" of all countries before the nineteenth century were based on such partial enumeration, supplemented by estimate of the unenumerated portion of the population. Such estimates are never more than approximate and are usually subject to a wide margin of error. Arbitrary coefficients for estimating the total population from enumerated heads of families, hearths, and the like, are necessarily employed, and the result, however credible as an estimate, cannot take the place of a direct summation of original and complete enumerative data. While sharp distinction should be made between a census which is the result of complete enumeration and one which is partly the result of estimate,

it is not always easy to say when a country made its first reliable census, since the two types grade into each other and even where a complete enumeration is ordered it is not always effectively carried out.

REGISTRATION AND CENSUSES IN ANCIENT TIMES

What little quantitative knowledge we have of population in ancient times is derived from registration of heads of families, taxpayers, and men of military age. Reports of "enumerations" in Babylonia and Egypt cannot be taken seriously.[1] Registers of births and deaths are said to have been kept in Egypt from very early times, and by 1400 B. C. an elaborate registration system, covering all heads of households, together with all members belonging to the household, was in force.[2] It does not appear, however, that the Egyptian registration was ever summated for the whole country. It is unlikely that the complete registration which Breasted finds in the fourteenth century B. C. lasted continuously through the vicissitudes of Egyptian history, though it comes to light again in Herodotus's account of Amasis II (570–522 B. C.).

The so-called censuses among the Biblical Hebrews were at best only partial enumerations for fiscal or military purposes. The first "census" Biblically recorded was that by Moses and Aaron during the wanderings in the wilderness, perhaps about 1500 B. C. No further count is recorded for about five centuries, when David ordered his famous census. This was not an enumeration in the modern sense, but only a count of the men of military age.[3] The Biblical account of the Lord's wrath at the taking of this census[4] remained an argument against census taking even as late as the eighteenth century. The captains of the host evidently did not have an easy job, for it took them over nine months to make the count. Schnapper-Arndt ventures to think that the anger of Jehovah was less against the census itself than against the slovenly way in which it was carried out.[5]

Knibbs states that in China "statistical results" date back to 3000 B. C. An older authority gives estimates of the Chinese population back to 2275 B. C., and of the number of families from 2 A. D.[6] From the first recorded count in 2275 B. C. to 1712 A. D., with few exceptions,

[1] Cf. Sir G. H. Knibbs, *Census of the Commonwealth of Australia*, 1911, Vol. 1, p. 1; Kahrstedt, "Die Bevölkerung des Altertums," *Handwörterbuch der Staatswissenschaften*, 4th ed., Vol. II, pp. 658, 659.

[2] Breasted, *History of Egypt*, 1906, p. 165.

[3] I *Chronicles* xxii, 2; II *Chronicles* ii, 17; Knibbs, *op. cit.* According to *Exodus*, xxx, 11–16, Moses was directed to number the people (males over 20 years of age) and levy a poll tax.

[4] Cf. I *Chronicles*, xxi; II *Samuel*, xxiv.

[5] *Sozialstatistik*, 1908, pp. 50, 51.

[6] J. Sacharoff, "Historische Übersicht über die Bevölkerungsverhältnisse Chinas," *Arbeiten der kaiserlichen russischen Gesandtschaft zu Pekin über China*, Berlin, 1858, Vol. II, pp. 127–195.

only the number of tax-paying households was recorded. From the latter date on, the total number of individuals is purported to have been ascertained.[1] In the first period, since the sole purpose of the count was fiscal, there is reason to believe that the returns were below the true figures. The returns forwarded to the central government were kept low by the local officials, who could thus divert a portion of the tax proceeds to their own pockets. Rockhill points out, moreover, that the returns are uncertain, not only because of official cheating, but also because the meaning of the term household or "hu" is uncertain and changeable. We also do not know the exact meaning of the term for individual, "mouth" or "k'ou"—whether it includes only adult males, adults of both sexes, or persons of all ages, exclusive of infants. The latter were never included in the lists at any period. Similar uncertainties abound in the interpretation of cadastral surveys and other population statistics in Europe from the earliest times to a late date.

Coming to Greece, we find nothing that suggests an enumerative census before post-Alexandrian times. Even then we do not have a complete population census. The census of Athens, by Demetrios of Phalerum, about 317 B. C., included all classes of males—citizens, metics, and slaves—but did not include women and children. It is not known how this census was taken or whether there were later Athenian censuses or censuses elsewhere in Greece. Beloch thinks that there is indirect evidence that censuses must have been taken, much later, in the large cities, especially Alexandria. Only in these hypothetical later city censuses do we arrive at the statistical conception of the population as a whole.[2]

According to Herodotus the Egyptian idea of registration was introduced into Athens by Solon. It there developed into a system of continuous record of the electorate. From the fourth century B. C., lists of citizens were engraved on stone and many of them have, therefore, been preserved. Theoretically, a full complement of these lists would enable an estimate to be made of the Attic population, and in fact the fragmentary data surviving from them constitute the only basis for an estimate. They were very far, however, from being anything in the nature of a population census. They did not include the women and children and the slaves. Even the metics, and, apparently, the thetes, were excluded.

In Rome, registration and enumeration of adult male citizens were

[1] Rockhill, "An inquiry into the population of China," *Smithsonian Institution, Annual Report*, 1904, p. 659.

[2] *Die Bevölkerung der griechische-römischen Welt*, 1886, pp. 4, 5.

made from a very early date, even before the Athenian census of Demetrios of Phalerum. The Roman census, however, at least before Augustus, was not a census in the modern sense. In the first census taken by Augustus, 28 B. C., the total was 4,063,000, whereas the total in the last Republican census, 69 B. C., was only 910,000. This great difference is interpreted variously by different historians.[1]

Censuses were supposed to be made every four years, but practical difficulties caused much irregularity. Before 443 B. C., ten, of doubtful authenticity, are alleged to have been made. From 443 to 318 B. C., fifteen are cited, an average of one every eight or nine years. In the succeeding 233 years, 318–86 B. C., there were forty-one, or one every five or six years. After 86 B. C., sixteen years elapsed without a census, a lapse due probably to the complications arising from the extension of citizenship to the Latin colonies and the Italian allies after the Social War, 91 B. C. Augustus took three censuses, at twenty-year intervals, 28 B. C., 8 B. C., and 14 A. D. Thereafter no census was taken for thirty-three years, when, under Claudius, one was taken in 47 A. D. The last census, the results of which we do not know, was taken under Vespasian in 72 A. D. Italians were now free of taxation and military service, and the census no longer had practical value. In the provinces, however, censuses continued to be taken. Provincial censuses had been made as early as the third century B. C., in Sicily, Sardinia, and Spain, but the provincial censuses were governed by special rules, and a general census of the Empire cannot be put together from them.

The Roman census was both an enumeration of adult male citizens and a tax list. It recorded the name and the age of every independent citizen and all members of his family, although the latter do not appear in the returns, together with the value of his property both real and personal. In the last category slaves were included, but it is not possible to judge from the census the number of slaves. Resident foreigners were not listed, but their property was. The lists were made up upon the sworn statements of the citizens. Returns for widows and orphans were made by their guardians; for emancipated sons by their fathers or grandfathers. The lists so constructed answered all governmental needs, especially taxation and recruiting. For taxation purposes the proletariat (*capite censi*) could be ignored.

The results of even the most careful of these censuses of male citizens

[1] The matter is too technical and too problematical to be gone into here. It is discussed by Beloch, *op. cit.*, pp. 370–378; H. Nissen, *Italische Landeskunde*, 1902, Vol. II, 1, pp. 112 ff.; E. Kornemann, "Die Censuszählen als statistisches Material," *Jahrbücher für Nationalökonomie und Statistik*, Vol. 69, 1897, pp. 291–296; E. Meyer, "Die Zahl der römischen Bürger unter Augustus," *ibid.*, Vol. 70, 1898, pp. 59–65; Tenny Frank, "Roman Census Statistics," *Classical Philology*, Vol. XIX, 1924, pp. 329–341.

are hardly comparable with our modern complete enumerations of whole populations. But the periodical repetition of even a partial enumeration at relatively short intervals over a period of four hundred years, as well as the increasing area covered, gives to the Roman census a significance that no other ancient population record possesses. By the time of Augustus the census covered all Italy, and with the exception of certain troubled times there is no reason to think that it was not reasonably complete so far as the adult male citizens were concerned. The results were not published broadcast. The Romans had no more interest in political arithmetic *per se* than they had in political economy. The census had a wholly practical and material purpose, and was carried no farther than that purpose required. The aim was not to afford later ages a demographic picture of Roman Italy, although the surviving figures enable us to get a rough outline of the growth of the Roman population.

No detailed results have come down to us for any Roman census. In only one or two cases have we anything but the total figure. With the exception of the Augustan census figures, which Augustus had engraved on the Monumentum Ancyranum, even the totals have survived only in the scattered works of the Roman historians, especially Livy.[1]

THE MIDDLE AGES

For a thousand years after the fall of Rome, numerical data on population are practically lacking. The earliest medieval record of any importance is the Domesday Survey made in England at the order of William the Conquerer in 1083–1086. Made to ascertain and record the fiscal rights of the king, this survey can be used as a basis for estimating the population only because of the fact that the names of property owners were recorded. Unfortunately, the most northerly counties, as well as London, Winchester, and some other towns, were omitted. Other than Domesday Book, the only European records, scattering and of later date, are those of surveys of hearths and lists of citizens for certain limited localities. A few registers of hearths in a few villages in Tuscany can be found for a period as early as the thirteenth century, but they are of no importance except as forerunners of the more plentiful data of the same kind available for later times.[2]

From the fifteenth century on we have much more reliable source material than for the earlier Middle Ages. Tax registers and lists of citizens, Bürgerverzeichnisse, become relatively plentiful, and begin to

[1] The above sketch of the Roman census has been condensed and adapted from Beloch's classical work, *Die Bevölkerung der griechisch-römischen Welt*, 1886, pp. 5–7, 307–311.

[2] Beloch, "Die Bevölkerung Europas im Mittelalter," *Zeitschrift für Socialwissenschaft*, Vol. III, 1900, p. 414.

be supplemented, especially in Italy, by genuine, though incomplete, enumerations of population. The first population census of which we have the records seems to have been that of Nürenberg in 1449.[1] Until late modern times a general census of population, or even of hearths, was impossible in Germany because the country was cut up into innumerable petty states. Nevertheless, a proposal for a general enumeration was brought before the Reichstag at Ausgburg in 1500 at the behest of the Emperor Maximilian. Nothing came of this.[2]

More scholarship, conjectural and otherwise, has been expended on the history of population in France than in any other European country, yet anything but a problematical estimate of the population of France before 1700 is out of the question. For the whole medieval period there are only two outstanding documents, both providing data as to hearths for limited areas. These documents, the polyptique of the Abbé Irminon, for the ninth century, and the report of 1328 on "Paroisses et feux des bailliages et sénéchaussées de France," raise as many problems as they solve. Neither of them is remotely comparable to a register of citizens or a partial census.[3]

A census of hearths was reputed to have been made in Spain, in 1482, by one Alonso de Quintanilla, at the order of Ferdinand and Isabella. These Catholic Monarchs wished to establish the Santa Hermandad on a national scale, and to this end desired full information as to the taxable capacity of the Kingdom of Castile, to which the census applied. Quintanilla expressly states that he made a count of the hearths or taxpayers in the whole kingdom and that their number was 1,500,000.[4] Quintanilla's word has been accepted by Spanish historians, who put the population of Spain at the end of the fifteenth century at 10,000,000, but the round number for the taxpayers leads Conrad Häbler, who has made the most critical study of Spanish population statistics, to believe that the count was never made and that Quintanilla simply estimated the number of hearths.[5]

[1] Cf. Karl Bücher, *Die Bevölkerung von Frankfurt am Main im XIV und XV Jahrhundert*, 1886, pp. 9, 10, 31–48; Beloch, "Die Bevölkerung Europas zur Zeit der Renaissance," *Zeitschrift für Socialwissenschaft*, Vol. III, 1900, p. 765.

[2] Beloch, *op. cit*, p. 777.

[3] On the polyptique of the Abbé Irminon see Levasseur, *La Population Française*, 1889, Vol. I, pp. 125–142; M. P. Lot, "Conjectures démographiques de la France au IXe siècle," *Moyen Age*, Vol. 23, pp. 1–27, 109–137; H. Sée "Peut-on évaluer la population de l'ancienne France?" *Revue d'Économie Politique*, July–Aug., 1924, Vol. 38, pp. 647 ff. On the report of 1328 see Levasseur, *op. cit.*, Vol. I, pp. 155–170; F. Lot, "L'état des paroisses et des feux de 1328," *Bibliothèque de l'École de Chartes*, Jan.–June, 1929, pp. 51–107, July-Dec., 1929, pp. 256–317.

[4] "Yo he contado muy ciertamente el numero de vesindades de sus reinos de Castilla, é de Leon," etc. Cf. Tomas Gonzalez, *Censo de Población*, Madrid, 1829, p. 94.

[5] Cf. Diego Clemencin, Elógio de la Réina Católico Doña Isabel, *Memorias de la Real Academia de la Historia*, Madrid, 1821, Vol. 6, pp. 601–603; Manuel Colmeiro, *Historia de la Economia Politica en España*, 1863, Vol. II, p. 13; Häbler, *Die wirtschaftliche Blüte Spaniens im 16.Jahrhundert und ihr Verfall*. Berlin, 1888, pp 144 ff.

EARLY MODERN TIMES

A remarkable list of population censuses, some partial, some complete, in Renaissance Italy has been brought to attention by Beloch and Italian scholars. The existence of the records of these censuses in the various Italian archives is probably unknown to many English and American students of population. The brief notice here given to them is taken in the main from the work of Beloch.[1] I have been unable to ascertain that anyone has followed up Beloch's lead in this rich material, although he himself states that in the Neapolitan archives alone there are 1416 volumes of the original enumeration lists of hearths and population, which if copied and analyzed would afford valuable information concerning the population of Italy in the noonday of its prosperity in the sixteenth, seventeenth and eighteenth centuries.[2]

For no region of the earth have we as old or as complete a series of censuses as we have for Sicily. The first of these Sicilian "descrizioni" was made in 1501. Then followed three others in the sixteenth century, six in the seventeenth, and four in the eighteenth. The movement of the Sicilian population can therefore be followed from the end of the Middle Ages to the beginning of the taking of modern censuses. The "descrizioni" gave for each commune the number of hearths, and the number of inhabitants, specified by sex. The male population was further classified into two age groups, 18 to 50 and over 50. However, all these particulars appear only in certain enumerations, those of 1583, 1615, 1642, 1652, 1713, and 1747. The enumerations were made by officials expressly appointed in the various communes.[3]

In the Kingdom of Naples regular enumeration of the population did not begin until 1765, but there were enumerations of hearths from 1465 on. During the Spanish régime only hearths were enumerated, by royal commissions by house to house canvass. While, as in Sicily, the name and age of each person appears to have been taken, no effort was made to summarize the total population, still less to classify it by age and sex.

Statistical data on the population of the Venetian Republic begin

[1] "La popolazione d'Italia nei secoli xvi, xvii, e xviii," *Bulletin de l'Institut International de Statistique*, Vol. III, 1888, pp. 1–42; "Die Bevölkerung Europas zur Zeit der Renaissance," *Zeitschrift für Socialwissenschaft*, Vol. III, 1900, pp. 765–786; "La popolazione della Sicilia sotto il dominion spagnolo," *Rivista Italiana di Sociologia*, Vol. VIII, 1904, pp. 28–45; "Die Volkszahl als Faktor und Gradmesser der historischen Entwicklung," *Historische Zeitschrift*, 3d series, Vol. 15, 1913, pp. 321–337; "Bevölkerungsgeschichte der Republik Venedig," *Jahrbücher für Nationalökonomie und Statistik*, 3d series, Vol. 18, 1899, pp. 1–49. Cf. also Maggiori-Perni, *Popolazione di Sicilia e di Palermo dal X al XVIII secolo*, Palermo, 1892

[2] "La popolazione d'Italia nei secoli xvi, xvii, e xviii," *Bulletin de l'Institute International de Statistique*, Vol. III, 1888, p. 8.

[3] Beloch, "La popolazione della Sicilia sotto il dominio spagnuolo," *Rivista Italiana di Sociologia*, Vol. VIII, 1904, p. 28; "La popolazione d'Italia nei secolo xvi, xvii, e xviii," *loc. cit.*, p. 3.

about the middle of the sixteenth century, though for the city of Venice and some parts of her territory much earlier material is available.[1] For the city of Venice enumerations of some sort, probably of adult males, are said to have been made as early as the twelfth century, but the results have not been preserved. Reliable data are not available until the early sixteenth century, when figures for men 15–60 years of age are found in the archives for three of the six districts of the city. A church census, the nature of which is not clear, gave the city in 1540 a population of 129,971. In 1552 and 1563 official censuses gave figures of 158,069 and 168,627 respectively, classified into men, women, boys and girls under 16, monks, nuns, beggars, hospitalers, and Jews. There was a similar census in 1581. Other enumerations followed at frequent and fairly regular intervals to 1696, when there is a lapse until 1760. Six enumerations in the eighteenth century are recorded.

For the Venetian Republic before 1548 only scattering data survive. In 1548, Stefano Tiepolo, "provveditore generale di Terraferma," ordered an enumeration (descrizione) of all the mainland territory of the Republic. Thereafter there was no general census until 1766, though there were numerous city and district enumerations. Finally, in 1766 a new census was taken of the whole state, and similar enumerations were continued to the end of the Republic. There is no reason, Beloch thinks, to doubt the accuracy of the later censuses, though the earlier enumerations are less reliable. In the latter, entire villages, sometimes entire districts, were omitted, and there were in the records errors in addition and of copying. In the greater part of the cases we are not informed as to the method of enumeration, and in consequence are often uncertain whether a given figure refers to the total population or otherwise, or whether it includes nursing babies, the soldiers, clergy, etc. In some cases, moreover, the figure reported to the government was based not on actual enumeration but on estimate, or a mixture of the two. Despite these difficulties, Beloch holds that it is easily possible to eliminate the major errors, since the data are so copious and means of control not lacking.[2]

For Tuscany, there were enumerations of hearths in the Florentine state in 1559, 1562, 1622, and 1642; in Sienna and its territory in 1612, 1640, 1670, 1677, 1686, and 1691; for the Grand Duchy of Florence, including Sienna, in 1738, 1745, 1751, 1758, 1766, 1791, and 1800; for the Republic of Lucca, in 1733, 1744, 1758, 1781. For Milan, during the Spanish epoch, there was only one enumeration, of hearths, prob-

[1] Beloch, "Bevölkerungsgeschichte der Republik Venedig," *Jahrbücher für Nationalökonomie und Statistik*, 3d series, Vol. 18, 1899, pp. 1–49.

[2] "La popolazione d'Italia nei secoli xvi, xvii, e xviii," *loc. cit.*, pp. 24, 25; "Bevölkerungsgeschichte der Republik Venedig," *loc. cit., passim.*

ably in 1542. Later, there were enumerations in 1763, 1778, and 1800.[1]

It is not surprising, as Beloch says, that in Italy more than elsewhere, from the end of the Middle Ages on, there was a lively sense of the need of statistical data concerning population, since Italy during the Renaissance was culturally the most advanced country of Europe. Nevertheless, the main object of the descrizioni was fiscal, and it was only gradually, and intermittently, that the practise of making enumerations of the whole population became common. The system of censuses of hearths or families remained in force in Naples and Milan to the later days of Spanish rule, but in almost all of the other states of Italy, censuses of population in the true sense of the word had been undertaken by the end of the fifteenth century. In the earlier enumerations it was customary to exclude children under three or five years of age, and also the clergy, or at least the monks and friars. Even in the fifteenth century, however, some states, notably Venice, Tuscany, and Sicily, and from the beginning of the sixteenth century others, began to include children of all ages. In some states the clergy continued to be excluded. In Sicily this was the case still in the eighteenth century. Moreover, since the enumerations were made primarily for fiscal purposes, communes exempt from taxation, which in some cases were large cities, were not included.

In some states, as in Naples and Sicily, the enumerations were executed directly by political authority, but in general the task was assigned to the parish priests, who transmitted their reports to the bishops, who in turn reported to the government. With all its drawbacks, this system was probably the best practicable at the time. The parish priests were not only in position to know the people of their parishes better than anyone else could; they were also less likely to encounter suspicion and opposition than direct agents of the government. Beloch, while perhaps not as sharply critical and exacting as a present-day administrative statistician would be, is convinced from his long study of the documents that the results are in general worthy of confidence.[2] At any rate, the mass of the material, extending over so long a period, and including at so early a time enumerations of whole populations, is sufficient to disprove once for all that Canada, the United States, or some of the American Colonies were the first to take complete censuses of population.

Turning again to Spain, we have for the sixteenth century richer statistical material than for any other country in Europe, with the exception of Italy. There was no reliable enumeration of the whole

[1] "La popolazione d'Italia nei secoli xvi, xvii, e xviii," pp. 19–21, 28 ff.
[2] *Ibid.*, pp. 1, 2, 25.

population of Spain, however, until the establishment of a General Statistical Commission in 1856. The first attempt at a complete enumeration was made in 1802. The censuses of 1768 in Castile and of 1787 and 1797 in Spain at large were evidently based on enumerations of hearths. The so-called censuses of 1482 (if one was actually made in that year), 1530, 1541, and 1594 were enumerations of hearths only—*vecinos* or *vecinos pecheros*, that is, either all heads of families or tax-paying heads of families. These censuses, moreover, were confined to Castile, although there are some data for certain other parts of Spain. Because of this and other differences in the bases of enumeration, the various counts are not comparable with one another without a good deal of critical and to some extent conjectural adjustment. Nevertheless, the statistics of Spain, and especially of Castile, enable us to secure a much more valid conception of the gross movement of population during the sixteenth century than we can possibly have for France, Germany, or England. The importance of the Spanish data, together with the difficulties of their interpretation, are such that they demand fuller and more critical discussion than is possible in a brief sketch.[1]

WESTERN EUROPE IN THE EIGHTEENTH CENTURY

Lively interest in quantitative data on population was evinced during the eighteenth century in France, and also in England. In both countries suggestions for national enumerations began to be made by the middle of the century. The Maréchal de Vauban had proposed an annual census as early as 1707.[2] The time was not ripe, however, and there was no attempt at a general census in France until 1791, when the Constituent Assembly ordered a general enumeration but was unable to bring it about. Through the seventeenth and eighteenth centuries, the government, notwithstanding its fiscal interest in population, especially in evidence during the ministry of Colbert, contented itself with such partial and indirect information as could be secured through the intendents.

At the close of the seventeenth century the intendents were directed to make a full report on the state of affairs in their districts—the number of towns, villages, and hamlets, the number of parishes, and the number of people in each. They were directed also to consult the old

[1] On the Spanish data, see, beside the works mentioned above (p. 362 note 5); P. G. Edge, "Pre-census Population Records of Spain," this JOURNAL, Vol. 26, 1931, pp. 416–423. Also in *Metron*, Vol. IX, 1932, pp. 229–249. This article, which consists mainly of an outline of the content of Gonzalez's basic collection, published in 1829, constitutes a good introduction to the material, but fails to give adequate background in the social and economic history of Spain.

[2] *Project d'une Dixme Royale*, 1707, pp. 215, 216.

registers to see whether the population had formerly been more numerous, and if so, to discover the cause of the decrease. The resulting Mémoires were collected in 1698–1700, and long continued to be the chief basis of population estimates. They were far, however, from constituting a census. Moreover their accuracy left much to be desired. Some gave the number of inhabitants (variously arrived at), some only the number of hearths. Nevertheless, they constitute the only general attempt before 1780 to ascertain the population of France. An analysis of them, by the Duc de Boulainvilliers, was published in 1727–28 under the title, *L'État de la France.*

During the eighteenth century there were a few local enumerations of provinces and parishes, but nothing on which it was safe to base an estimate of the general population.[1] For a time all that was done was to work over the old Mémoires des Intendents. Just before the Revolution there were a dozen or so estimates, revealing the lively interest in the subject.[2] The government during the last twenty years of the Ancient Régime tried seriously to ascertain the size of the population, but this could not be done without a real census.

Active opposition to the proposals for a general enumeration was exerted on religious grounds. Saint-Simon referred to those "dénombrements impies," which had always called down the wrath of God on the people who permitted them to be made.[3] The impracticability of general enumerations was widely reiterated by many authorities.[4] It was admitted that a general census was greatly to be desired, but held that the unrest of the people at the least activity of the government made its execution impossible. The curés were the only persons who might be able to carry it out, but they shared the suspicions of their parishioners, and were utterly ignorant of the social value of a census.

During the Revolution, laws which prescribed the annual ascertainment of the population in each commune remained a dead letter in most départements. The duty was laid on the prefects, but no fixed date of enumeration was set. The Conseil d'État, while recognizing the desirability of a fixed date, considered it impossible to require it. Another attempt at enumeration in 1801 failed, as the results were generally recognized to be extremely defective. The same is true of the census

[1] Levasseur, *La Population Française*, 1889, Vol. I, p. 219; A. des Cilleuls, *La population de la France devant 1789;* Moraud, *Histoire de l'Académie des Sciences*, 1779, p. 472.

[2] Messance, *Recherches sur la population de Généralités d'Auvergne, de Lyon, de Rouen et de quelques autres Villes du Royaume*, 1766; Necker, *Administration des Finances*, 1784; Calonne, *Population du Royaume*, 1787.

[3] *Mémoires de Saint-Simon*, ed. Chéreul, Vol. VIII, p. 137.

[4] Cf. Brion de la Tour, *Tableau de la Population*, 1789; Necker, *op. cit.*, 1784; de Pommelles, *Tableau de la Population de toutes les Provinces de France*, 1789.

of 1806. The reports of the prefects show that the returns in some prefectures were made up by multiplying the number of hearths by 5. In others the returns for 1806 were constructed by modifying those of 1801 by correction for births and deaths from 1802 to 1806. Some prefects attributed the inexactitude of the returns to the "nonchalence habituelle" of the local officials. From 1806 to 1820 the question of a general enumeration was not raised, partly because of the skepticism of the great mathematician Laplace, but mainly because Napoleon did not want a general count. Laplace's skeptical attitude was due to his knowledge that the proper official regulations had not been provided in 1801 and 1806, and to his belief that they could not be provided. The results of 1821 were made up probably by simple estimate, and the censuses of 1826 and 1831 were apparently not much better. The first reliable French census was that of 1836, though not till 1881 was an enumeration made on the same date in all parts of the country.[1]

In England the situation was similar to that in France, although England, after it once started, was not so long in securing a reliable census as was France. The more settled political conditions in England may explain this fact. Thanks especially to the pioneering work in "political arithmetick" by John Graunt and William Petty, estimates and conjectures as to the increase or the decrease of the population of England were made frequently during the eighteenth century. In 1753 Thomas Potter introduced a bill in Parliament providing for a general enumeration. The proposal was opposed on the ground that a census would reveal England's weakness to her enemies. Religious prejudice, also, was not lacking. It was held that a census would inevitably be followed by "some public misfortune or epidemical distemper." The proposal was cried down, also, as subversive of the last remains of English liberty. The bill was thrown out by the House of Lords.

The final action of England in taking its first census in 1801 seems to have been due to the arguments of John Rickman. In 1796 he had written a paper entitled "Thoughts on the Utility and Facility of a General Enumeration of the People of the British Empire," which was afterwards published in the *Gentleman's Magazine*. Rickman set forth the economic advantages of ascertaining the number of the people, the probability of the population being much larger than the usual estimates, and the facility with which the population could be deduced from the parish registers. His paper was communicated to Charles

[1] A. des Cilleuls, "Les recensements de la population en France," *Séances et Travaux de l'Académie des Sciences Morales et Politiques*, Vol. 172, 1909, pp. 782–794; F. Faure, "The development and progress of statistics in France," in John Koren, *History of Statistics*, 1918, p. 287.

Abbot, afterwards speaker of the House of Commons. Abbot introduced the census bill in 1800, and on its passage offered to Rickman the supervision of the census.[1]

The decision of Parliament to risk a general enumeration may have been influenced by the fact that the young United States had made a general count of the people, without to any notable degree suffering the displeasure of the Almighty. It is probable, also, that the new trend of population theory introduced by Malthus's Essay in 1798 may have had its influence. Fear that the population was decreasing had now given way to fear of overpopulation and to solicitude over the nation's ability to support an increase in numbers. The preamble of the act providing for the census stated that "in times like these, when subsistence of the people is in question, it is surely important to know the demand for which we are to supply."

The censuses in the Italian states during the sixteenth, seventeenth and eighteenth centuries might well have served as suggestion and models to other countries, had they been known beyond the confines of Italy. The Italian censuses, however, were not taken at regular intervals, nor were those of Canada and the American colonies. The United States census of 1790 was the first one of a regularly recurring series with a decennial interval established by constitutional provision.[2] While there were population censuses in certain continental countries in the first third of the nineteenth century, especially in the German states, hardly any of these countries had established regularly recurrent enumerations before 1861.

The birthplace of continuous vital statistics on a national scale is Sweden, which affords the only uninterrupted series of data which have come down to us from the eighteenth century. In 1746 the mathematician, Pehr Elvius, Secretary of the Swedish Academy of Science, undertook to compile a complete list of births and deaths for the whole kingdom from the parish registers, and to calculate from this the total population. A bill for making tabular records of the Swedish population was approved by the king in 1748. A Tabellenkommission, under the leadership of Wargentin, made careful abstracts of the parish registers from 1749 on. These abstracts were combined every three years (later every five) into so-called censuses. This could be done because, theoretically at least, each parish register would yield each year an accurate account of the parish population—persons registered from previous years, plus new births and persons coming in from other parishes, and less deaths and persons going out to other parishes. In a

[1] O. Williams, *Life and Letters of John Rickman*, 1912, p. 40.
[2] *Constitution of the United States*, Art. I, sect. 2 (c).

country of limited area and relatively small population, where there is little migration, such a continuous process of demographic bookkeeping was possible, though doubtless it was far from accurate. The procedure of the tabulating commission, which was made permanent by royal rescript of 1756, can hardly be called enumeration.[1]

In the severe condensation of the present survey it has been necessary to omit any treatment of the American colonial and Canadian censuses. Description of the Canadian censuses may be found in Koren and of the colonial censuses in *A Century of Population Growth* (Bureau of the Census, 1909). It is unfortunate, however, that the Census Bureau was not able to publish a fuller account, with more specific documentation.

[1] League of Nations, *Statistical Handbook Series*, No. 6, *Scandinavian Countries*, 1926, p. 10; Schnapper-Arndt, *Socialstatistik*, 1908, p. 53. "On the registration systems of Norway, Denmark, and the Netherlands," see Koren, *History of Statistics*, 1918, and League of Nations, *Statistical Handbook Series*, No. 1, 1924.

FERTILITY OF SOCIAL CLASSES IN VARIOUS TYPES OF COMMUNITIES OF THE EAST NORTH CENTRAL STATES IN 1900 [1]

By Clyde V. Kiser

This paper is devoted to an analysis of the birth rates of specific social classes in metropolitan, moderately urban, village and rural areas of 1900. Previous studies [2] have indicated that fertility rates are higher in rural than in urban areas and that in both city and country there exists an inverse relation between fertility and social class. In a recent census monograph, Thompson [3] demonstrated an inverse relation between fertility and size of community, but his data could not be analyzed from the point of view of social class. Thus it is impossible to know to what extent the differences he found were simply due to variations in social class composition of the communities, or whether they persist when the fertility of specific social classes within each type of community is considered.

In the official censuses of 1890, 1900 and 1910, the enumerators asked each married woman the number of children she had ever borne. Since the occupations of the husbands were also recorded, these data, though never tabulated by the Census Bureau, are valuable for studies of fertility of women in the various social strata.[4]

Through the courtesy of Professor W. F. Ogburn, Director of Research of the President's Research Committee on Social Trends, the Research Division of the Milbank Memorial Fund was supplied basic data from the 1900 Census pertaining to the fertility of 11,490 married women living in Chicago,[5] 13,800 in five cities ranging from approximately 50,000 to 125,000 population,[6] 10,152 in forty-eight villages [7] of

[1] From the Division of Research, Milbank Memorial Fund.

[2] See list of studies in Bibliography.

[3] Warren S. Thompson, *Ratio of Children to Women, 1920*. Census Monograph XI, Government Printing Office, Washington, 1931, 242 pp.

[4] With the exception of (f) and (j), all of the studies listed in the Bibliography have been based exclusively upon data tabulated from the original enumeration schedules of the 1910 Census.

[5] In the case of Chicago it was necessary to confine the sample to wards in which a substantial proportion of the wives could qualify with respect to nativity and parentage. Such area-selection was rarely necessary in smaller cities, villages and rural areas.

[6] Columbus, Dayton, Evansville, Grand Rapids and Peoria.

[7] Villages of the 5,000 class by states were as follows: *Indiana*—Auburn, Bluffton, Boonville, Columbia City, Decatur, Franklin, Garrett, Kendallville, Lebanon, Plymouth, Portland, Rochester, Rushville, Tipton and Warsaw; *Illinois*—Anna, Carlinville, Effingham, Flora, Geneseo, Harvard, Hillsboro, Marseilles, Metropolis, Morris and Princeton; *Michigan*—Allegan, Big Rapids, Charlotte City, Coldwater, Greenville, Hastings, Hillsdale and Lapeer; *Ohio*—Barnesville, Bridgeport, Bryan, Celina, Clyde, Eaton, Greenfield, Hillsboro, London, Napoleon, Nelsonville, Pomeroy, Toronto and Wilmington.

fewer than 5,000 inhabitants, and 6,990 in strictly rural areas of fourteen counties in Ohio, Michigan, Illinois and Indiana.[1]

Since the chief purpose of this study is to compare the fertility rates of women of specific social classes in communities of varying degrees of urbanization, the data were restricted in order to eliminate the effects of such variables as geographic location, color, nativity, marital status and age composition. Thus the sample was confined to the East North Central states, to native white married women of native parentage who were only once married [2] and were living with husbands of similar parentage at the time of the enumeration. In order to avoid complicated analyses, only women who were still in the child-bearing age when enumerated were considered.

On the basis of the reported occupations of the husbands, the wives included in the non-rural samples were divided into four conventional socio-economic groups, professionals, business class, skilled workers, and unskilled laborers. Rural women could be classified as wives of farm owners, farm renters and farm laborers since such information was obtainable directly from the census schedules.

The division of wives into social classes upon the basis of the occupations of husbands, of course, cannot give entirely satisfactory results. It may be objected that occupation is only one of several criteria of social class, that individuals of widely different character may be found among the representatives of particular occupational groups, that the social class of the husband is not necessarily that of the wife, and that except in a rigidly stratified society, there is a continuous movement of individuals from one social class to another. While the above criticisms are doubtless true, one must admit that such grouping of wives affords four broad classes which, taken as a whole, differ from each other with respect to economic, social and educational attainments.

There are many factors which influence the existing fertility of given social classes, among the more important of which are ages of wives, ages of wives at marriage, economic status, education and other related influences inherent in the interests and style of life characteristic of particular social classes. A few students have attempted by one

[1] Counties from which the rural samples were drawn were as follows, by states: *Illinois*—Bureau, Champaign and Jersey; *Indiana*—Orange, Randolph and Steuben; *Michigan*—Allegan, Gratiot and Lenawee; *Ohio*—Fayette, Highland, Madison, Medina and Wood.

[2] Information concerning the number of times married could not be obtained directly from the 1900 Census schedules. If the duration of marriage exceeded the age of the oldest child, however, it was assumed that neither the husband nor the wife had been married more than once. Obviously such an indirect method could not yield absolutely accurate results. Its inadequacy consisted in the fact that it did not eliminate those cases in which the earlier marriage was childless and those in which all of the children either had died or had left home prior to the 1900 enumeration. It seems reasonable to believe, however, that the number of cases thus erroneously included in the sample is small and that they comprise a group whose earlier marriages were least likely to modify the fertility of existing unions.

method or another to examine the relative influence of the separate factors. In this paper, however, the composite rather than the separate effects of such factors are examined for each social class in the several types of communities. Since the age of the wife determines the length of time during which the other factors may operate, however, it is only after age is held constant that one can attribute fertility differences to characteristics inherent in the social classes or in communities themselves.

In this study fertility is expressed in terms of children ever born per 100 married women. Such a rate is cumulative in that it represents the total past fertility rather than current or annual rates of reproduction. Two statistical devices have been used in controlling the factor of age—the first is that of age-specific rates (cumulative rates for wives in specific age groups) and the second is the total rates standardized for age. The first makes possible the comparison of fertility rates of women of designated age groups. The second affords a means of discovering what rate of fertility would obtain in two or more groups if the same age distribution prevailed among the women.

TABLE I

CHILDREN BORN PER 100 WIVES BY AGE OF WIFE AT THE 1900 CENSUS FOR EACH SOCIAL CLASS AND TYPE OF COMMUNITY

Social class and community	Total under 45	Age of wife at census					
		15–19	20–24	25–29	30–34	35–39	40–44
Professional							
Chicago	141	*	51	93	133	184	212
Moderately urban	155	*	*	98	146	210	245
Village	186	*	*	110	172	251	276
Business							
Chicago	143	*	57	93	140	192	222
Moderately urban	163	*	67	109	170	209	258
Village	184	*	83	130	184	227	267
Skilled workers							
Chicago	163	*	79	124	167	220	242
Moderately urban	196	45	94	154	218	271	323
Village	226	53	107	180	239	318	361
Unskilled laborers							
Chicago	200	*	*	151	195	*	*
Moderately urban	251	62	125	192	262	363	422
Village	263	56	125	214	295	378	425
Rural							
Farm owners	297	*	133	201	285	351	375
Farm renters	262	65	118	198	304	384	447
Farm laborers	221	61	130	207	319	372	*

* Rates based on fewer than 100 cases are not shown. For number of cases on which these rates are based, see Table IV.

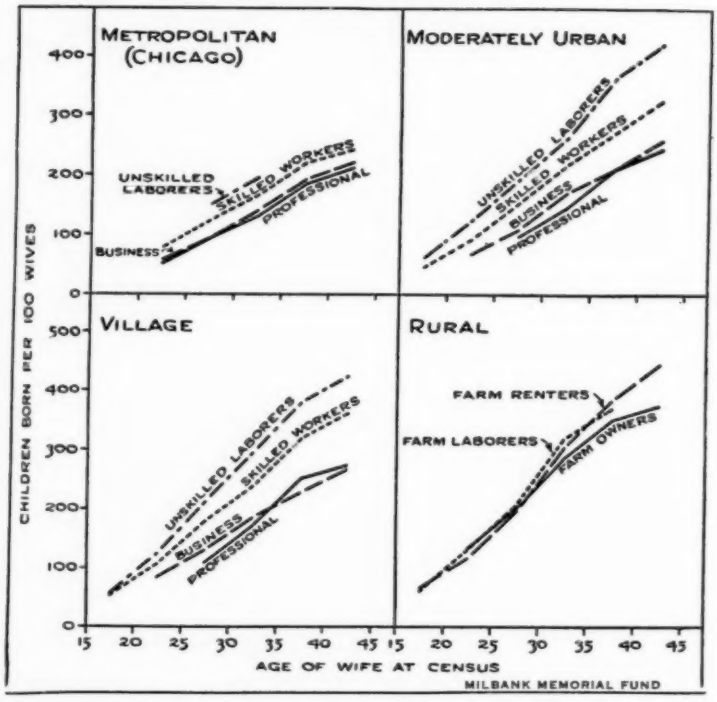
In Table I the age-specific rates of women in separate social classes are presented for metropolitan (Chicago) moderately urban and village communities. On the basis of these data, Charts I and II were prepared. The former indicates the social class comparisons for each

type of community; the latter shows community differences for each social class.

Four facts of some significance are noteworthy: First, in each type of community studied an inverse association between fertility and social

CHART I

SOCIAL CLASS DIFFERENCES IN FERTILITY BY AGE OF WIFE IN EACH TYPE OF COMMUNITY



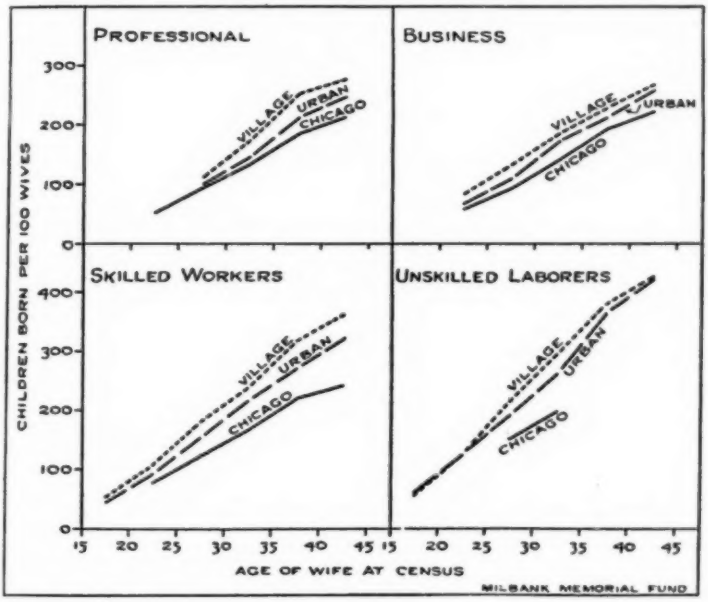
status was manifested. Second, with the exception of that of unskilled laborers living in moderately urban communities and in villages, the fertility rate of each non-rural social class was lower than that of the farm owners, the least fertile rural class. Third, for each urban social class, fertility was highest in villages, intermediate in urban centers of 50,000–125,000 population, and lowest in Chicago. Fourth, a striking similarity of all communities appears with respect to the range of difference in fertility of component social classes.

It is unnecessary to deal at length with the fact of differential fertility according to social class. Previous analyses of United States census data by the Research Division have demonstrated the manner in which social classes differ in fertility in moderately urban and in

strictly rural communities. The data gathered for this paper permitted the extension of such analyses to one metropolitan and to many village communities. In each type of community, unskilled laborers were most fertile, skilled workers were intermediate, and the white-collar

CHART II

DIFFERENCES BETWEEN NON-RURAL COMMUNITIES IN THE FERTILITY OF WIVES OF IDENTICAL AGE AND SOCIAL STATUS



workers were least fertile. But whereas there was conspicuous difference between the fertility of unskilled laborers and that of the skilled workers, at practically all ages and in each type of community, the proximity of the rates for the business and professional classes attests the generally undifferentiated nature of the fertility of the white-collar groups in 1900. In the rural population, the age-specific rates indicate that in 1900 differentiation in the fertility of specific classes was not so clearly manifested as among the urban classes.[1] The rates for farm owners 35 years of age and over, however, are probably significantly lower than those for farm renters and farm laborers of the same age groups, and the total rates standardized for age indicate that a differen-

[1] A study of the trends of fertility of social classes based upon data from East North Central cities of the 50,000–125,000 class revealed that during the interval 1900–1910, the birth rate of the professional class fell definitely below that of the business workers, and that the rural classes became more differentiated. See Bibliography (j).

tiation with respect to fertility of the three rural classes was at least beginning to be shown at that time.

Rural women were conspicuously more fertile than the non-rural. The total rural rate standardized for age was 270 children per 100 wives. Similar rates for non-rural women were as follows: village, 220; moderately urban, 193; and Chicago, 144. Within the rural group itself the total rate standardized for age for farm owners was 262, that for farm renters was 281, and that for farm laborers was 306. The total rate standardized for age for the least fertile rural group, farm owners, surpassed that of the most fertile class in Chicago, unskilled laborers; was practically the same as the rate for such laborers in moderately urban centers; and with the exception of that for unskilled laborers was higher than any rate shown by village social classes. The rate for village unskilled laborers was 278—higher than that for farm owners, almost the same as that for farm renters, but lower than that for farm laborers.

Perhaps more interesting than rural-urban differences are those which appear between the three types of non-rural communities when the birth rates of women of identical social classes are compared. Fertility rates of each urban class were lowest in Chicago, intermediate in smaller cities, and highest in villages. As indicated in Chart II, the differences between communities are small at certain age periods of the wives, but (with one minor exception) throughout all ages and in each social class, the three non-rural communities assume the relative positions described above with respect to fertility.

TABLE II

STANDARDIZED CUMULATIVE BIRTH RATES FOR EACH TYPE OF COMMUNITY AND FOR COMPONENT SOCIAL CLASSES*

Community	Total	Professional	Business	Skilled workers	Unskilled laborers	Farm owners	Farm renters	Farm laborers
Chicago	144	130	135	162	198	...	...	...
Moderately urban	193	146	157	205	263	...	...	...
Village	220	171	172	233	278	...	...	...
Rural	270	...	...	...	...	262	281	306

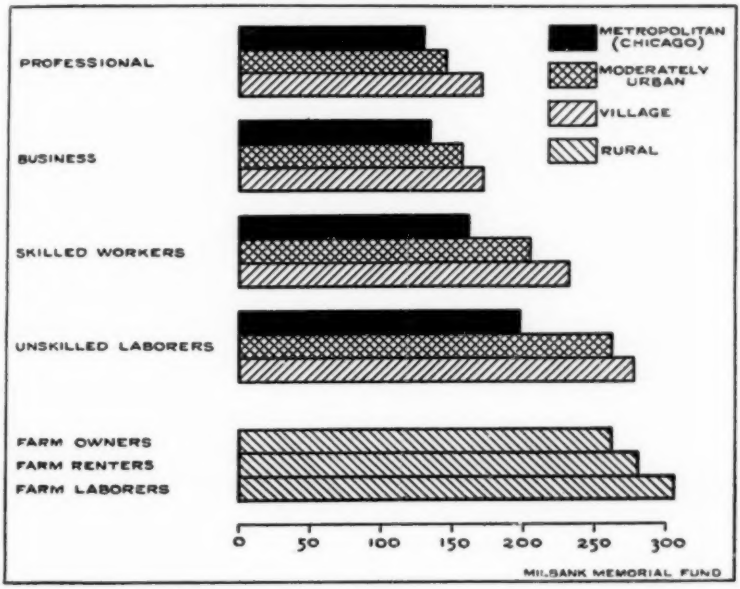
* The standard adopted is the same as that used in previous analyses of 1910 data, i.e., the age distribution of the total sample secured from the 1910 Census schedules. See (a), Bibliography.

Total rates standardized for age for each social class and for each type of community facilitate summary comparisons, Table II, Chart III. The fertility of the professional class in Chicago was surpassed 12.3 per cent by professionals in smaller cities and 31.5 per cent by women of the same social class in villages. The birth rate of the business class

was 16.3 per cent higher in urban districts and 27.4 per cent higher in village communities than in Chicago. As for skilled workers, rates were 26.5 per cent higher in urban communities than in Chicago and skilled workers residing in villages were 43.8 per cent more fertile than similar

CHART III

CUMULATIVE BIRTH RATES STANDARDIZED FOR AGE FOR WOMEN OF IDENTICAL SOCIAL CLASSES BUT RESIDENT IN VARIOUS TYPES OF COMMUNITIES



craftsmen of the metropolis. The fertility of the unskilled laborers of Chicago was surpassed 32.8 per cent and 40.4 per cent by representatives of the same occupational status in the urban and village communities respectively. Thus, birth rates for specific social classes, as well as those for total communities, fall with increasing urbanization.

Another comparison of fertility rates which holds constant the factors of age and social class composition is afforded by standardization for age and social class. Such comparison is one which would exist if each community had the same age and social class distribution. In standardizing for social class the total rates standardized for age for each social class were weighted by the proportions by which the specific social classes were represented in the total non-rural sample. Thus single indices were obtained for each type of community, just as the total rates standardized for age are summary figures derived from age-

specific rates in each social class. After both age and social class composition were held constant, the Chicago fertility rate was 154, the moderately urban rate was 189, and the village rate was 210. Under such conditions the moderately urban rate, based upon the samples studied, was 22.7 per cent higher than that of Chicago, and the village rate surpassed that of the metropolis by 36.4 per cent.

While the fertility rates of each social class were lowest in Chicago, intermediate in cities of moderate size, and highest in villages, the difference between social classes was strikingly similar in each of the three types of communities. Not only was the order of the classes the same with respect to fertility in each type of community but the spread of the rates was not greatly different. This similarity in the spread of the rates is not readily apparent from Chart I because of the absence of rates for age groups in which the number of cases was small. It is better shown by the percentages which the standardized rate for each social class forms of that for all classes combined in the same type of community. The latter rate was standardized both for age and social class in order to eliminate biases arising from the greater weight of certain classes in one community than in another.

The rates for the least fertile social class, professional, were 84 per cent, 77 per cent, and 81 per cent of the total community rates in Chicago, moderately urban centers and villages, respectively. The rates for the most fertile class, unskilled laborer, were 129 per cent, 139 per cent and 132 per cent of the respective community rates standardized for age and social class. See Table III, Chart IV.

TABLE III

PER CENT WHICH THE STANDARDIZED BIRTH RATE OF EACH SOCIAL CLASS FORMS OF THE TOTAL RATE FOR ALL CLASSES COMBINED, EACH TYPE OF COMMUNITY *

Rate standardized for age and social class	Chicago		Moderately urban		Village	
	154		189		210	
	Rate	Per cent	Rate	Per cent	Rate	Per cent
Professional	130	84	146	77	171	81
Business	135	88	157	83	172	82
Skilled workers	162	105	205	108	233	111
Unskilled laborers	198	129	263	139	278	132

* Rates for all classes combined were standardized for both age and social class.

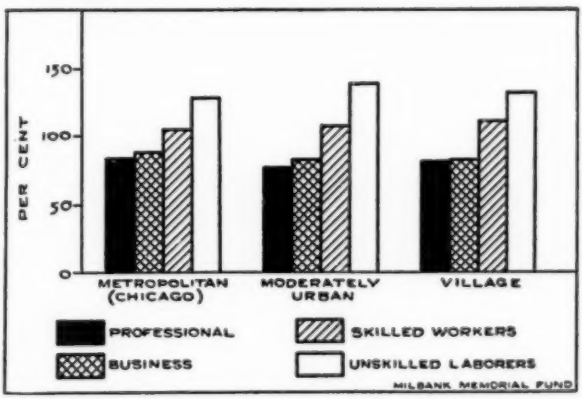
Since a previous study of the 1900 fertility rates in the moderately urban and strictly rural communities represented in the present study had revealed a more pronounced differentiation of the social classes

with respect to fertility in cities of 50,000 to 125,000 population than in strictly rural communities, it seemed possible that the results of the present investigation might reveal an increasing degree of divergence of fertility rates between social classes as one passes from village to urban,

CHART IV

SIMILARITY OF THE ORDER AND SPREAD OF BIRTH RATES FOR THE SOCIAL CLASSES IN DIFFERENT TYPES OF COMMUNITIES

The standardized rate for each class is shown as a per cent of that for all classes combined in the same communities. In rates for all classes each social class was given the same weight in all communities shown. See Table III.



and from urban to metropolitan communities. On the contrary, however, a striking similarity appears and the small differences that do exist indicate slightly greater spread in the moderately urban communities than in either Chicago or in villages.

While an interpretation of this small difference can be no more than suggestive, there is the interesting possibility that in moderately urban centers the urban influences conducive to low birth rates had a greater effect upon the white-collar classes than on the laboring classes than was the case in villages where neither class was greatly affected by urban mores and in Chicago where the stringent conditions of urban life affected the lower classes as well as the white-collar workers. Whatever the explanation may be, the striking fact of this comparison is that in 1900 there was little difference between the relative spread of the birth rates of the social classes in villages with about 5,000 population, and Chicago with over one and one-half millions.

It is necessary to remember certain characteristics of the data before formulating personal conclusions. First, the data refer simply to the reproductivity of native white married women in unbroken families.

The rates cannot be interpreted as indices of the actual extent to which women in the various social classes were reproducing within the several communities. If foreign born were included in the sample, for instance, one would expect the present rates for unskilled laborers to be

TABLE IV

NUMBER OF WIVES CONSIDERED BY AGE AT THE 1900 ENUMERATION FOR EACH SOCIAL CLASS AND FOR EACH TYPE OF COMMUNITY

Social class and community	Total under 45	Age of wife at census					
		15–19	20–24	25–29	30–34	35–39	40–44
Professional							
Chicago	1,492	6	126	353	405	356	246
Moderately urban	873	6	96	210	213	201	147
Village	855	8	88	183	215	206	155
Business							
Chicago	6,697	64	819	1,592	1,634	1,438	1,150
Moderately urban	4,609	68	649	1,055	1,089	945	803
Village	2,911	56	339	639	642	623	612
Skilled workers							
Chicago	2,812	59	443	662	639	550	459
Moderately urban	6,136	191	1,239	1,518	1,277	1,041	870
Village	3,659	161	673	851	742	649	583
Unskilled laborers							
Chicago	489	12	83	108	110	89	87
Moderately urban	2,182	116	419	501	418	408	320
Village	2,727	167	535	612	540	458	415
Rural							
Farm owners	3,065	41	261	492	677	735	859
Farm renters	2,787	108	568	687	595	483	346
Farm laborers	1,138	139	369	276	160	121	73

more affected in Chicago than in moderately urban and village communities. Also, by virtue of the fact that the rates are simply for married women they do not take into account differences in the proportion of potential mothers who are married. The problem at hand, however, was to examine the differences in fertility which seem to accrue from characteristics inherent in the types of communities themselves and for that reason, variables such as race, nativity, age and marital status were held constant.

In the second place, the data refer to female residents of given communities at the time of the 1900 enumeration. An unknown proportion of the wives included in each type of urban community considered migrated from the rural districts after all or part of their children were born or at least after a period of long residence in an environment where rural culture prevails. In a strict comparison of differences in fertility of women in communities of varying size of population, it would be desirable to choose for study only those wives who were indigenous residents of the communities in which they were found at the time of the enumeration or were migrants from communities of similar types. In regard to the migration, it is also necessary

to bear in mind the fact there are selective as well as determinative factors which help to account for differences observed between social classes and communities. In respect to fertility, these factors are so intricately interwoven that it is practically impossible to separate them. The lower rates of fertility of wives in Chicago were doubtless due in some measure to the lack of attractiveness of a metropolis for large families migrating from rural areas. Such families encounter greater difficulties in a metropolis than in smaller cities and villages in obtaining satisfactory and economical living arrangements. A further interpretation necessitates further knowledge of the selective factors involved in the process of migration from rural areas to urban centers of varying size.

In the third place, while the data indicate an inverse association between fertility and size of community, no claim is made that size of population *per se* is the responsible factor for the differences in birth rates observed. The cities have not been studied separately, nor have they been thrown into categories of *gradually* increasing size.[1] The four types of communities studied are so widely different in size that the mode of life in one is commonly regarded as being much different from that characteristic of another.

In summary, the data indicate that in each type of community studied there was an inverse relation between fertility and social status. Rural wives were most fertile, village wives stood second, residents of moderately urban centers were third, and Chicago wives were least fertile. The inverse association between fertility and social status holds true when women of identical social status in the three types of non-rural communities are considered separately. Although the rates for all urban social classes were highest in villages, intermediate in moderately urban centers, and lowest in Chicago, there was striking similarity in the order and spread of the rates for component classes in each type of community.

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THE DISPLACEMENT OF WORKERS THROUGH INCREASES IN EFFICIENCY AND THEIR ABSORPTION BY INDUSTRY, 1920–1931

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The status of employment and unemployment statistics in the United States is such that figures on the current volume of employment or unemployment are necessarily based either on reasonable guesses or rather vague estimates. If this is true of such cover-all data as "total unemployment," how much more true must it be of data relating to such subdivisions as "technological unemployment," or to figures giving the extent of fluctuations in employment due to one or another of the many forces which bring about such fluctuations. In point of fact, a true measurement of the extent of unemployment in the United States would necessitate a daily or weekly enumeration of the unemployed. Short of such censuses this could be accomplished only by means of a national system of employment exchanges. Such exchanges, armed either with authority to compel every unemployed worker to register, or powerful incentives such as reasonable assurance of a job or unemployment insurance, could, by means of proper clerical and statistical devices, measure not only the extent of unemployment, but also the various factors contributing to fluctuations in employment. Any such system seems still to be in the distant future as far as the United States is concerned. And yet, the demand for this type of information is becoming ever greater with the growing interest in all kinds of labor legislation, especially insurance against unemployment.

The analysis described in this paper was undertaken in an attempt to devise a statistical procedure which would afford an approximate measure of two of the more important types of employment fluctuations: those due principally to changes in the physical volume of output, and those which can be ascribed chiefly to changes in technological and managerial efficiency.

Existing indexes of employment reflect neither the full extent of fluctuations in employment nor the interplay of the forces which cause these fluctuations. The first deficiency is due in a large measure to the fact that the employment indexes are based upon numbers reported on the payrolls—which numbers include part-time employees as well as full-time employees. The second deficiency is due simply to the lack of direct information. These employment indexes, therefore, had to be abandoned in this study and new indexes constructed. Again, in order

to derive the degree of displacement due to changes in the output per man-hour it was necessary to construct a measure of the output per man per hour. This, in turn, necessitated the use of some index of physical production and the construction of an index of man-hours worked. In the analysis of these factors this study confines itself to Manufacturing Industries, Class I Railroads, Bituminous Coal Mining and Anthracite Coal Mining.

It is fully realized that the results obtained are subject to the deficiencies inherent in the data which were used in the computations, and yet, it seems desirable to submit these results as something which tends to indicate the *direction* of the movement of important factors in employment even if the full extent of these movements cannot be said to have been measured satisfactorily.

Manufacturing Industries.—The material used was obtained from two separate and independent sources: the Federal Reserve Board and the National Industrial Conference Board. The Federal Reserve Board publishes indexes of factory payrolls and indexes of physical production in manufacturing industries, while the "Index of Average Hourly Earnings in 24 Manufacturing Industries" and the "Index of Average Full-Time Hours Per Week" were obtained from publications of the National Industrial Conference Board.

The Federal Reserve Board index of physical production was computed by the use of the so-called "aggregate method" and is based upon primary data of considerable variety, all of which provide current indications of the volume of production of principal industries, expressed in physical quantity units. The industries thus directly or indirectly represented include about 80 per cent of the value added by all manufacturing industries in 1923. "Some of the more important manufacturing industries not included in the index are canning, butter and cheese, certain chemicals and drugs, railroad repair shops, and musical instruments. Others which are only indirectly represented by subsidiary industries are machinery and equipment, clothing, furniture, and printing and publishing of books and magazines."[1]

The Federal Reserve Bulletin index for factory payrolls is based in "largest part" on statistics of payrolls that become available monthly and which now embrace 50 industries accounting for about 80 per cent of total factory payrolls in the United States.[2] This index is revised from time to time by the use of the statistics from the biennial Census

[1] *Federal Reserve Bulletin*, March, 1927, p. 170.

[2] *Federal Reserve Bulletin*, November, 1929, pp. 707–708. The industries which are included currently but not prior to 1923 are: petroleum refining, shipbuilding, manufacture of fertilizers, rubber boots and shoes, and automobile tires.

of Manufactures. The last revision is based on the Census of 1927. The current fluctuations are, therefore, "determined altogether by the statistics reported by manufacturing establishments every month, while the general level of the index in 1928 and 1929 is determined in part by an allowance based on the Census of 1927 for industries that do not report currently."[1]

The National Industrial Conference Board indexes of hourly earnings and full-time hours are based upon approximately 9 per cent of the total number of wage earners in manufacturing industries.[2] In spite of the smallness of the sample, these indexes were used in this study rather than the available data published by the United States Bureau of Labor Statistics. The reasons for this preference are the following. Though the absolute figures of the National Industrial Conference Board are open to objections it was, nevertheless, felt that the *relative* movement of these figures mirrors fairly faithfully the true movement of the correct actual figures—whatever these may be. Furthermore, the annual averages of the National Industrial Conference Board are based upon monthly returns and consequently can be expected to be more sensitive than the Bureau of Labor Statistics material which often is representative of no more than a single month during any one year. The following tabulation affords a comparison between the two series of hourly earnings:

	Link Relatives of	
	Bureau of Labor Statistics index of hourly earnings in industries other than agriculture	National Industrial Conference Board, hourly earnings in 24 manufacturing industries
1920	100	100
1921	93	87
1922	95	94
1923	104	109
1924	103	104
1925	101	100
1926	101	101
1927	101	101
1928	100	100
1929	101 *	102

Source: The Bureau of Labor Statistics series was computed on the basis of index numbers in the *Monthly Labor Review*, February, 1931, p. 143, while the National Industrial Conference Board series was computed on the basis of actual data published in *Wages in the United States, 1914–1930*, p. 47.
* Preliminary.

It will be noticed that, especia.. subsequent to 1923, there is very little difference between the relative fluctuations of the two series. Finally, the National Industrial Conference Board series is the only readily available series on hourly earnings which presents homo-

[1] *Federal Reserve Bulletin*, November, 1929, p. 708.
[2] National Industrial Conference Board, *Wages in the United States 1914–1930*, p. 16.

geneous data in a comparable form throughout the entire period under consideration.

The data described above were used as in Table I.

TABLE I

MANUFACTURING INDUSTRIES—PAYROLLS, PRODUCTION AND LABOR COST, 1920–1931
(1920 = 100)

(1) Year	(2) Index of payrolls *	(3) Index of physical volume of production **	(4) Index of labor cost per unit $\frac{(2)}{(3)} \times 100$	(5) Index of hourly earnings, 24 manufacturing industries §	(6) Index of full-time hours per week, 24 manufacturing industries §	(7) Index of full-time weekly earnings $\frac{(5) \times (6)}{100}$
1920	100	100	100	100.0	100.0	100.0
1921	65	77	84	86.5	99.4	86.0
1922	69	100	69	81.5	100.0	81.5
1923	87	118	74	89.1	100.0	89.1
1924	81	110	74	92.6	99.2	91.9
1925	86	124	69	92.4	100.0	92.4
1926	88	127	69	93.6	99.6	93.2
1927	86	124	69	94.9	99.2	94.1
1928	86	131 †	66	95.4	99.4	94.8
1929	92	140 †	66	97.0	99.4	96.4
1930	74	112 ‡	66	97.0	97.6	94.7
1931	56	96 ‡	58	93.0	96.2	89.5

Sources:
* Federal Reserve Board.
** 1920–1922, converted to 1920 base from data in *Recent Economic Changes*, National Bureau of Economic Research, Table 19, p. 449; 1923–1929, this JOURNAL, December, 1930, p. 457, Table 2: "Volume of Production in Manufactures."
† Preliminary.
‡ Federal Reserve Board index of production, corrected on the assumption that the error involved in the Federal Reserve Board index of 1930 and 1931 is the same as that involved in the preceding five years as revised in the JOURNAL article (see footnote **).
§ National Industrial Conference Board.

First, the Index of Factory Payrolls was divided by the Index of Physical Volume of Production. The result, multiplied by 100, yielded an Index of Labor Cost per unit of output. Then the Index of Hourly Earnings was divided by the Index of Labor Cost in order to obtain the output per man-hour.[1] (See Table II, column 2.)

The operation, $\frac{1}{\text{Output per Man-Hour}} \times 10{,}000$, is, therefore, equivalent to "the number of men needed to produce the physical output of 100 men in the base year of the index."[2] This number does not, how-

[1] The reasonableness of this operation becomes clear, when a concrete example is considered. Assume the labor cost of a single unit to be $2.00, and the average hourly earnings of a worker engaged in the manufacture of that product, 50 cents. The 50 cents are, therefore, equal to the labor cost of ¼ of a unit, or ¼ of a unit is produced during one hour of work.

[2] For, if one man produced ¼ of a unit during one hour of work in 1920, and ½ a unit during one hour of work in 1930, then only ½ the number of workers are needed in order to produce the same number of units of output. Or, if the productivity in 1920 (¼ of unit) is called 100 per cent, the productivity in 1930 (½ unit) becomes 200 per cent and the number of men needed in 1930 to produce the physical output of one man in 1920 is equal to 100 per cent÷200 per cent, or ½. Since relatives are employed throughout the calculations and since, furthermore, the changes are measured from the base year as 100.0, the computations are facilitated by computing the reciprocal of the index of output per man-hour in any one year and multiplying it by 10,000.

ever, take the fluctuations in full-time hours during the period into consideration. Since the work-hours in the standard work-week tended to decline during the years 1920–1931, a certain number of workers who would have been displaced by increases in efficiency were

TABLE II

MANUFACTURING INDUSTRIES—PER CENT CHANGE IN EMPLOYMENT, BY TYPE, 1920–1931

(1920 = 100)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Year	Index of output per man-hour	Number of men needed to produce the output of 100 men in base year (1920)	Per cent changes in employment since 1920			Index of employment
			Due to changes in output per man-hour *	Due to changes in volume of physical output	Total net change	
1920	100.0	100.0	0.0	0.0	0.0	100.0
1921	102.5	98.2	− 1.8	−22.6	−24.4	75.6
1922	118.1	84.7	−15.3	0.0	−15.3	84.7
1923	120.8	82.7	−17.3	+14.9	− 2.4	97.6
1924	125.8	80.1	−19.9	+ 8.0	−11.9	88.1
1925	133.2	75.1	−24.9	+18.0	− 6.9	93.1
1926	135.1	74.3	−25.7	+20.1	− 5.6	94.4
1927	136.8	73.7	−26.3	+17.7	− 8.6	91.4
1928	145.3	69.2	−30.8	+21.5	− 9.3	90.7
1929	147.6	68.2	−31.8	+27.2	− 4.6	95.4
1930	146.8	69.8	−30.2	+ 8.3	−21.9	78.1
1931	159.4	65.2	−34.8	− 2.6	−37.4	62.6

* These changes in employment are not due *solely* to changes in output per man-hour. They include also the increases in employment opportunities resulting from the decline of the full-time hours of work per week. Since the full-time hours changed only slightly from 1920 to 1929, the effect on employment was negligible.

able to retain their jobs. The magnitude of this effect was determined in the following manner. By multiplying the hourly earnings by the number of full-time hours per week, the full-time weekly earnings were obtained (Table I, column 7). These weekly earnings, when divided by the labor cost per unit of output, yielded the output per man-week; the reciprocal of this last figure was, therefore, the equivalent of the number of man-weeks needed to produce the physical output of 100 man-weeks in 1920.[1] Since all of the operations described above were carried out by means of relatives, the index numbers appearing in Table II, column 3, are applicable to full-time man-years as well and were used as such. The differences between the data in Table II, column 3, and 100.0 are, therefore, the per cent changes in employment brought about as the immediate result of changes in technological and managerial efficiency (Table II, column 4).

It is fully realized that changes in the output per man-hour and the

[1] See footnotes 1 and 2 on page 386.

accompanying changes in the volume of employment may be brought about by a multitude of factors. Among such factors may be: the relative strength of trade-unionism, changes in wage-policy, changes in the hours of work, managerial improvements, technological improvements, changes in the labor-personnel, fluctuations in the price-level, general business conditions, the flow of work, etc. Again, the change in the output per man-hour may, and no doubt does, itself, produce conditions which may in turn result in further changes in the general complex of factors affecting the volume of employment and the character of the fluctuations. This article does not, however, concern itself with the remote causal relationships among the various factors. It regards as within its purview only the quantitative aspects of the various types of fluctuations in employment, and bases its analysis upon the existing relationship between the physical volume of output, the physical volume of output per man-hour, and the total number of man-hours worked, namely: $\frac{\text{Output}}{\text{Man-Hours}} = \text{Output per Man-Hour.}$

The output per man-hour having increased steadily during the years 1920–1931, except in 1930, these fluctuations in employment, due to changes in technological and managerial efficiency, were negative in every single year during the period, and, in 1931, reached a point where approximately 35 men out of every 100 men employed in 1920 had been displaced by the various devices which made for an increase in the physical output per man-hour.

Some of these displaced men, the great majority as will be seen later, were, however, reabsorbed by the increased employment necessitated by the growing physical volume of output during the period 1920–1929. During cyclical recessions, on the other hand, a certain number of workers were added to those "technologically" displaced by drops in employment caused by violent declines in the volume of physical output. In order to determine the extent of these cyclical influences on the volume of employment, Table II, column 3, was multiplied by the index of physical production (Table I, column 3). The result obtained, when divided by 100, yielded an index of employment in terms of equivalents to full-time employment, thus excluding any inflations or deflations due to part-time work or over-time. This last index (Table II, column 7) when subtracted from 100 gave the per cent changes in employment since 1920 (Table II, column 6). It was then inferred that the difference between the "total net change" in employment (Table II, column 6) and the fluctuations due to changes in the output per man-hour (Table II, column 4) was due to the changes in the volume of physical output. These per cent changes in employ-

ment, caused by the cyclical variations in the physical volume of production, are given in Table II, column 5.[1]

An inspection of the data in Table II reveals a number of significant points.

First, a chart of the index of employment obtained by the method described in this paper, plotted together with the index of factory employment published by the Federal Reserve Board, would show that both indexes move in the same manner, except that the Federal Reserve Board index fluctuates less violently. This is precisely as would be expected since the Federal Reserve Board index is based upon monthly reports of numbers of men on the payrolls, thus including partial as well as full-time employment, while the derived index is given in terms of full-time equivalents and is, therefore, more sensitive to the changes in the physical volume of production. It should also be noted that the discrepancies between the two employment indexes are widest during the depression years 1921, 1924, 1927, 1930 and 1931. This fact tends to support the explanation that the difference is due to the presence of a cushion in the labor forces included in the Federal Reserve Board index which tends to absorb the effect of over-time and to minimize the fluctuations due to partial employment. As a consequence, the derived index dips deeper in times of depression and rises higher during periods of active business. The following tabulation gives the two employment indexes together with the differences between them.

Second, the index of output per man-hour (Table II, column 2) indicates clearly the pressure which is exerted upon the productive apparatus to bring about greater efficiency during periods of business

[1] One of the principal difficulties inherent in the statistical procedure used in this paper is the fact that the original data underlying the entire analysis are in the form of index numbers. In order to avoid unnecessary multiplication of the errors contained in the basic data, errors, moreover, the precise magnitudes of which are unknown, the attempt was made to reduce the arithmetical operations to the smallest possible number and to avoid operations with index numbers which *derived* from the basic data. As a consequence, the actual computations were performed not in the manner indicated in the text, but in accordance with the formulae given below.

$$\text{(A) Labor Cost per Unit} = \frac{\text{Payrolls}}{\text{Physical Volume of Production}}$$

$$\text{(B Output per Man-Hour} = \frac{\text{Hourly Earnings}}{\text{(A)}} = \frac{\text{Hourly Earnings} \times \text{Production}}{\text{Payrolls}}$$

$$\left.\begin{array}{l}\text{(C) Number of Men in any Year needed to produce the Output of 100 Men in the Base Year}\end{array}\right\} = \frac{1}{\dfrac{\text{Full-Time Weekly Earnings}}{\text{(A)}}} = \frac{\text{Payrolls}}{\text{Production} \times \text{Full-Time Weekly Earnings}}$$

$$\text{(D) Employment} = \text{(C)} \times \text{Production} = \frac{\text{Payrolls}}{\text{Full-Time Weekly Earnings}}$$

(E) Total Net Change in Employment = 100 − (D)

(F) Change in Employment due to Change in Output per Man-Hour = 100 − (C)

(G) Change in Employment due to Change in Physical Volume of Production = (E) − (F)

Year	Indexes of employment in manufacturing industries 1920=100		Derived index minus Federal Reserve Board index (points)
	Federal Reserve Board	Derived index	
1920	100.0	100.0	0.0
1921	75.9	75.6	−0.3
1922	83.3	84.7	+1.4
1923	96.3	97.6	+1.3
1924	88.9	88.1	−0.8
1925	92.6	93.1	+0.5
1926	93.5	94.4	+0.9
1927	91.7	91.4	−0.3
1928	89.8	90.7	+0.9
1929	93.5	95.4	+1.9
1930	81.5	78.1	−3.4
1931	68.5	62.6	−5.9

depression and the intensified competitive conditions that go with it. The tabulation below gives the year to year per cent changes in the output per man-hour in manufacturing industries.

It may be observed that the average annual increase in output per man-hour was about 4.4 per cent and that every depression year, 1921, 1924, 1927, and 1930, was followed by a more than average rise in the rate of increase, while every peak year during the period, 1923, 1926, and 1929 was a year of a relatively low rise in efficiency. The year 1930 not only failed to show an increase in the output per man-hour, but actually registered a decline. The explanation for this may well be sought in the widespread efforts, sponsored by high governmental officials, public bodies and individual employers, to maintain a larger number of employees on the payrolls than was warranted by the physical volume of output, by means of the so-called "stagger plan" and other devices calculated to increase part-time employment.

The third item of significance is the relationship between the employment index and the index of physical production. Link relatives

Year	Year to year changes in output per man-hour
	Per cent
1920	0.0
1921	+ 2.5
1922	+15.2
1923	+ 2.3
1924	+ 4.1
1925	+ 5.9
1926	+ 1.4
1927	+ 1.3
1928	+ 6.2
1929	+ 1.6
1930	− 0.5
1931	+ 8.6
Average	+ 4.4

of these indexes reveal that increases in the volume of production are accompanied by less than proportionate increases in employment, while a decline in the volume of production is followed by a more than proportionate drop in employment. The reason for this difference in the type of fluctuation becomes clear when it is observed that the index of output per man-hour is steadily rising: a rise in the volume of output

(1)	(2)	(3)
Year	Link relatives of index of production	Link relatives of index of employment
1920	100.0	100.0
1921	77.0	75.6
1922	129.9	112.0
1923	118.0	115.2
1924	93.2	90.3
1925	112.7	105.7
1926	102.4	101.4
1927	97.6	96.8
1928	105.6	99.2
1929	106.9	105.2
1930	80.0	81.9
1931	85.7	79.0

consequently requires a less than proportionate increase in the volume of employment; conversely, a decline in the volume of output results in a more than proportionate shrinkage in the number employed. It follows, therefore, that in order to retain or increase the total volume of employment, improvements in the efficiency of industrial processes must be accompanied by a rate of growth in the physical volume of output, which is equal to or greater than the rate of increase in efficiency. It follows furthermore that, given a country with an increasing number seeking gainful employment and a progressive technology, the rate of growth of the physical volume of production must not only be greater than the rate of growth of efficiency, but it must be sufficiently more rapid to create an additional demand for employment large enough to absorb the new additions to the labor supply. The absence of the above conditions is bound to result in a constantly growing "labor reserve."[1]

Fourth, the general tendency in the physical volume of output during the period 1922–1929 seems to have been such as to absorb the great majority of the workers displaced as a result of increased productivity. In 1929, for example, out of about 32 men in every 100 who had been

[1] This generalization does not take into consideration the possible equalization between the various factors, by means of such expedients as the shortening of the working day or the working week. Nor has an attempt been made to establish whether the conditions cited above had obtained in the past. In order to determine these relationships a host of additional data would have to be collated—a task which lies beyond the scope of this paper.

displaced since 1920, about 27 had been absorbed by the increased volume of output. The remaining 5 may or may not have found employment in industries other than manufacture.

The above analysis is based upon the year 1920. Since that year was one of extremely high employment, it was thought advisable to measure the changes in employment from other vantage points. What were the movements from year to year? What were they from one cycle to another?

To accomplish the first objective, link relatives were constructed of column 3, Table II, and column 7, Table II. The results appear in Table III.

TABLE III

MANUFACTURING INDUSTRIES—YEAR TO YEAR PER CENT CHANGES IN EMPLOYMENT, BY TYPE, 1920–1931

(1)	(2)	(3)	(4)	(5)	(6)
Year	Link relatives of Table II, col. 7	Link relatives of Table II, col. 3	Per cent changes in employment measured from preceding year		
			Due to changes in the output per man-hour *	Due to changes in volume of physical output	Total net change
1920	100.0	100.0	0.0	0.0	0.0
1921	75.6	98.2	− 1.8	−22.6	−24.4
1922	112.0	86.3	−13.7	+25.7	+12.0
1923	115.2	97.6	− 2.4	+17.6	+15.2
1924	90.3	96.9	− 3.1	− 6.6	− 9.7
1925	105.7	93.8	− 6.2	+11.9	+ 5.7
1926	101.4	98.9	− 1.1	+ 2.5	+ 1.4
1927	96.8	99.2	− 0.8	− 2.4	− 3.2
1928	99.2	93.9	− 6.1	+ 5.3	− 0.8
1929	105.2	98.6	− 1.4	+ 6.6	+ 5.2
1930	81.9	102.3	+ 2.3	−20.4	−18.1
1931	80.2	93.4	− 6.6	−13.2	−19.8

* See footnote * to Table II.

It will be seen that, taking every year as a base for the year immediately succeeding, a number equal to or greater than those displaced during any one year (except the depression years 1921, 1924, 1927, 1930 and 1931) were absorbed during that year. Thus, if we apply the derived employment index (column 7, Table II) to the average number of wage earners during the year 1929 as reported by the United States Census of Manufactures for that year, we can estimate the actual number of those who were displaced as a result of the increased output per man-hour and the changes in employment as a result of changes in the physical volume of output. The 1929 Census of Manufactures reported 8,808,000 as the average number of wage earners on the payrolls. According to a compilation by the United States Bureau of Labor

Statistics the per cent of full-time operations during 1929 was 98.[1] If we apply this percentage to the census figure, we get an equivalent number of wage earners employed full-time of 8,632,000. Using this figure as a starting point we obtain the results given in Table IV.

Although, as was suggested above, during years of active business a number equal to those displaced was absorbed by the increase in output, this growth in the physical output was not once during the period 1920–1930 large enough to absorb a number equal to those displaced during the depression years as well. The number remaining unabsorbed fluctuated from year to year and amounted to approximately a half million in 1929, two millions in 1930, and three and one-third

TABLE IV

MANUFACTURING INDUSTRIES—YEAR TO YEAR CHANGES IN EMPLOYMENT, BY TYPES, 1920–1931

(1)	(2)	(3)	(4)	(5)	(6)
Year	Number of wage earners * employed in manufacturing industries	Changes in employment (+) or (−)			
		Due to changes in the output per man-hour **	Due to changes in physical volume of output	Net change during current year	Net change since 1920
1920	9,048,000	0	0	0	0
1921	6,840,000	−163,000	−2,045,000	−2,208,000	−2,208,000
1922	7,664,000	−935,000	+1,759,000	+ 824,000	−1,384,000
1923	8,831,000	−183,000	+1,350,000	+1,167,000	− 217,000
1924	7,971,000	−276,000	− 584,000	− 860,000	−1,077,000
1925	8,424,000	−495,000	+ 948,000	+ 453,000	− 624,000
1926	8,542,000	− 93,000	+ 211,000	+ 118,000	− 506,000
1927	8,270,000	− 68,000	− 204,000	− 272,000	− 778,000
1928	8,207,000	−503,000	+ 440,000	− 63,000	− 841,000
1929	8,632,000	−116,000	+ 541,000	+ 425,000	− 416,000
1930	7,067,000	+197,000	−1,762,000	−1,565,000	−1,981,000
1931	5,664,000	−467,000	− 936,000	−1,403,000	−3,384,000

* Note that these are full-time equivalents. The average number of wage earners as given by the census were: 1921—6,944,315; 1923—8,776,646; 1925—8,381,511; 1927—8,349,755; 1929—8,808,000.
** See footnote * to Table II.

millions in 1931. If we cumulate the data in column 3, Table IV, and compare them with the cumulated data of column 4, Table IV (taking signs into consideration), we can observe the lag between displacement and absorption (see Table V).

Thus we note that by 1923 a number equal to 83 per cent of those displaced during the years 1921–1923 had been re-absorbed in manufacturing industries, while, if the period 1921–1925 is considered, only 70 per cent of the displaced were taken up by 1925. If, however, a time lag is allowed for the absorption process, it is found that of those

[1] See United States Department of Commerce: *Survey of Current Business*, Annual Supplement, 1931, p. 186, Table 95.

TABLE V

MANUFACTURING INDUSTRIES—TIME LAG BETWEEN DISPLACEMENT AND ABSORPTION

(1)	(2)	(3)	(4)	(5)	(6)
Year	Cumulative effect of displacement factor (number of wage earners) *	Cumulative effect of absorption factor (number of wage earners) **	Per cent that col. (3) is of col. (2)	Per cent that col. (3) is when lagged ONE year behind col. (2)	Per cent that col. (3) is when lagged TWO years behind col. (2)
1920	0				
1921	— 163,000				
1922	—1,098,000				
1923	—1,281,000	+1,064,000	83	97	
1924	—1,557,000				
1925	—2,052,000	+1,428,000	70	92	111
1926	—2,145,000	+1,639,000	76	80	105
1927	—2,213,000				
1928	—2,716,000	+1,875,000	69	85	87
1929	—2,832,000	+2,416,000	85	89	109
1930	—2,635,000				
1931	—3,102,000				

* Column (3), Table IV, cumulated.
** Column (4), Table IV, cumulated.

displaced in the years 1921 and 1922, 97 per cent were absorbed one year later; of those displaced in 1921–1924, 92 per cent were taken in one year later and all had been absorbed two years later; on the other hand only 87 per cent of the victims of technical and managerial progress during the years 1921–1926 had found jobs as late as two years after their displacement. Even the peak year of 1929 had managed to absorb a number equal to only 89 per cent of those displaced between 1920–1928 within a lag of one year. These data seem to indicate that during the period 1920–1929, the process of absorption, when not impeded by cyclical recessions, lasted approximately one and one-half years.[1] A similar analysis, using monthly data, may disclose more accurate time relationships between these two factors in the fluctuations of employment.

The analysis described above was repeated on a cycle to cycle base, measuring cycles from peak to peak and giving the end years of a cycle only one-half the weight of the middle years. The results indicate first, that taking the recession as well as the revival years between 1920 and 1929 into consideration, the average number employed in manufacturing industries tended to increase until 1926. During the years 1926 to 1929, however, the absorptive capacity of the manufacturing industries had already begun to lag behind the displacement effects of the improved productive technology. Although the number of workers

[1] The depression years 1921, 1924, 1927, and 1930–1931 were eliminated from the computations in Table V because the absorption process can be observed clearly only during years of active business while periods of recession either halt the process entirely or serve to slow the process down materially.

remaining unabsorbed during the period 1926 to 1929 was very small, amounting to approximately 8,000 or 0.1 per cent of the average number employed during 1923–1926, conclusions as to unemployment would be unwarranted since this analysis does not take into consideration either the growth of the population or occupational mobility; also, the time lag between displacement and absorption should be remembered. This lag results in unemployment which, depending upon the growth of the particular industry in which it occurs, and the age, adaptability, and other characteristics of the worker whom it strikes, may be of a permanent nature, may be extremely protracted, or of very short duration. The eventual absorption of a *number equal to those displaced* but not necessarily including those displaced is, of course, of small comfort to the victims of displacement.

Class I Railroads.—In addition to the Manufacturing Industries, the factors influencing the volume and fluctuations in employment on Class I Railroads and in Coal Mining were subjected to a similar analysis. It was found that the principal difference between manufacturing and railroading is that manufacturing showed a tendency to absorb its displaced workers, while the railroads not only failed to absorb them but tended to add to those displaced because of technical and managerial improvements another group who cannot find employment on railroads as a result of a downward trend in the physical volume of output. Thus, a comparison between the cycle covering the years 1926–1929 and the preceding cycle 1923–1926 shows a total decline of about 230,000 workers or approximately 12 per cent of those employed during 1923–1926. This decline is made up of 130,000 who were displaced by increased technological and managerial efficiency and 100,000 who lost their jobs because of a drop in the physical volume of output.

What the results would be if the entire field of "Transportation" were taken into consideration can only be guessed at, though it is certain that the development of motor transportation served to offset, at least in part, the decline in employment on railroads.

Coal Industry.—Due to the nature of the underlying material the coal industry had to be divided into two separate industries: Bituminous and Anthracite.

The Bituminous Coal industry, not unlike railroads, shows a downward tendency in the physical volume of output. As a consequence, the diminution in the total number of wage earners in the industry is a resultant of the diminishing volume of output as well as of the increased mechanization of the industry and other factors making for a greater output per man-day. The decline in employment during the years 1926–1929 as compared with 1923–1926 amounted to about 20,000

TABLE VI

SUMMARY TABLE OF THE DISPLACEMENT OF WORKERS BY CHANGES IN TECHNOLOGICAL AND MANAGERIAL EFFICIENCY * AND THEIR ABSORPTION BY INDUSTRY

1921–1931

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Year	Manufacturing industries				Class I railways			
	Changes in employment		Net change		Changes in employment		Net change	
	Due to changes in the output per man-hour *	Due to changes in the physical volume of output	During current year	Since 1920	Due to changes in the output per service hour *	Due to changes in the physical volume of output	During current year	Since 1920
1921.....	−163,000	−2,045,000	−2,208,000	−2,208,000	+ 2,000	−494,000	−492,000	−492,000
1922.....	−935,000	+1,759,000	+ 824,000	−1,384,000	−36,000	+100,000	+ 64,000	−428,000
1923.....	−183,000	+1,350,000	+1,167,000	− 217,000	−52,000	+286,000	+234,000	−194,000
1924.....	−276,000	− 584,000	− 860,000	−1,077,000	−47,000	−103,000	−150,000	−344,000
1925.....	−495,000	+ 948,000	+ 453,000	− 624,000	−82,000	+ 80,000	− 2,000	−346,000
1926.....	− 93,000	+ 211,000	+ 118,000	− 506,000	−39,000	+ 93,000	+ 54,000	−292,000
1927.....	− 68,000	− 204,000	− 272,000	− 778,000	+ 9,000	− 67,000	− 58,000	−350,000
1928.....	−503,000	+ 440,000	− 63,000	− 841,000	−74,000	− 5,000	− 79,000	−429,000
1929.....	−116,000	+ 541,000	+ 425,000	− 416,000	−26,000	+ 39,000	+ 13,000	−416,000
1930.....	+197,000	−1,762,000	−1,565,000	−1,981,000	+12,000	−233,000	−221,000	−637,000
1931.....	−467,000	− 936,000	−1,403,000	−3,384,000	+ 1,000	−273,000	−272,000	−909,000

* See footnote * to Table II.
** Totals of Bituminous and Anthracite Coal.
† Not including the coal industry, for which the 1931 figures were not yet available at the time of writing.
†† Not including the 1931 decline in the coal industry (see footnote †) but including the decline in the coal industry from 1920 to 1930, i.e. 264,000 workers.

or approximately 4 per cent. Seventeen thousand of this number were displaced by changes in the output per man-day while 3,000 were dropped as a result of a decline in output.

An analysis of material covering other industries engaged in the supply of power, light and heat from sources other than coal, might well show an increase in numbers employed as large or larger than the decline in bituminous coal.

The Anthracite industry, too, suffers from the declining volume of output. Unlike, however, any of the preceding industries, the Anthracite industry seems to show a decline in output per man-day rather than an increase. This is due not to neglect in the mechanization process of the industry, but in part to the increasing inaccessibility of the coal to be mined and in part to a slight incomparability of the data.[1] Another peculiarity of the industry is that its fluctuations in output and employment are influenced most markedly not by the course of general business conditions but by the duration of the agree-

[1] Beginning with 1923, a small tonnage of culm-bank coal handled through breakers and hitherto counted as fresh-mined coal has been excluded, the figures on output per man-day are therefore not exactly comparable with earlier years; the difference, however, is small. (See U. S. Department of Labor, *Monthly Labor Review*, February, 1932, p. 292.)

TABLE VI—*Continued*

SUMMARY TABLE OF THE DISPLACEMENT OF WORKERS BY CHANGES IN TECHNOLOGICAL AND MANAGERIAL EFFICIENCY * AND THEIR ABSORPTION BY INDUSTRY

1921-1931

Year	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
	Coal industry**				Totals for the group of industries			
	Changes in employment		Net change		Changes in employment		Net change	
	Due to changes in the output per man-day *	Due to changes in the physical volume of output	During current year	Since 1920	Due to changes in technological and managerial efficiency *	Due to changes in the physical volume of output	During current year	Since 1920
1921 ...	−15,000	−165,000	−180,000	−180,000	−176,000	−2,704,000	−2,880,000	−2,880,000
1922 ...	−27,000	− 62,000	− 89,000	−269,000	−998,000	+1,797,000	+ 799,000	−2,081,000
1923 ...	−15,000	+224,000	+209,000	− 60,000	−250,000	+1,860,000	+1,610,000	− 471,000
1924 ...	+ 8,000	− 94,000	− 86,000	−146,000	−315,000	− 781,000	−1,096,000	−1,567,000
1925 ...	− 7,000	− 19,000	− 26,000	−172,000	−584,000	+1,009,000	+ 425,000	−1,142,000
1926 ...	+ 5,000	+102,000	+107,000	− 65,000	−127,000	+ 406,000	+ 279,000	− 863,000
1927 ...	−11,000	− 66,000	− 77,000	−142,000	− 70,000	− 337,000	− 407,000	−1,270,000
1928 ...	−21,000	− 25,000	− 46,000	−188,000	−598,000	+ 410,000	− 188,000	−1,458,000
1929 ...	−12,000	+ 29,000	+ 17,000	−171,000	−154,000	+ 604,000	+ 455,000	−1,003,000
1930 ...	−23,000	− 70,000	− 93,000	−264,000	+186,000	−2,065,000	−1,879,000	−2,882,000
1931 ...	.....	.....	.....	.....	−466,000†	−1,209,000†	−1,675,000†	−4,557,000††

ments between the coal mine operators and the dominant trade union organization. The total decline in employment in this industry is approximately 34,000 since 1920, all of which is the result of losses incurred since 1927, and is due almost wholly to a drop in the volume of output.

A summary of the effects of the depression years 1930 and 1931 upon the state of employment in the group of industries included in this analysis, presents the following picture. (See Table VI.)

During the two years, 1930 and 1931, approximately 2,700,000 workers in the manufacturing industries lost their jobs as a result of the drop in the volume of output. In addition to that, about 270,000 were displaced as a result of such technological and managerial improvements as brought about an increase in the output per man-hour. Close to three million workers, or approximately 34 per cent of those who had been employed in manufacturing industries in 1929, were therefore dropped from the payrolls. These figures include partial as well as complete losses of employment, i.e., they are in terms of full-time employment equivalents.

On Class I Steam Railroads the drop in employment during 1930 and 1931 amounted to about half a million workers or 30 per cent of those employed in 1929, and was due wholly to the decline in the

volume of output. In point of fact, the output per service-hour *declined* during the two years, thus counteracting the drop in output to the extent of approximately 13,000 employees.

At this writing the coal data for 1931 are not yet available, but a group total including the coal industry up to and including the year 1930, indicates that in the three industries, manufacturing, railroading and coal mining, some three and a half million or one-third fewer workers were employed in 1931 than in 1929.

Conclusions.—The preceding analysis was undertaken in an attempt to devise a statistical method for the measurement of the influence exerted upon the level of employment by technological and managerial improvements. Although the procedure used in this essay cannot be said to have solved the problem, it is offered as one approach to the question, adapted to the present status of statistical information bearing on factors relating to employment. The results of this analysis, qualified as they are by the deficiencies of the underlying statistical data as well as by those of the statistical procedure, nevertheless establish certain relationships, warrant a number of definite conclusions, and raise a series of significant questions.

1. The first thing that stands out when the rate of increase of the output per man-hour in the manufacturing industries is analyzed, is the fact that this rate tends to diminish during years of active business and to accelerate under the pressure of business depressions.

2. Second, certain definite relationships between the rate of increase of the output per man-hour, the physical volume of output, and the labor supply become evident. These relationships may be stated in the following terms:

A. Given a continuously rising output per man-hour,

a. An increase in the physical volume of output is accompanied by a *less* than proportionate increase in the volume of employment.

b. A decline in the physical volume of output results in a *more* than proportionate shrinkage in employment.

B. In order that the so-called "labor reserve" either diminish or remain numerically constant in size, in a country with an increasing number seeking gainful employment and a progressive technology, the following conditions must obtain:

a. The physical volume of output must increase at a faster rate than the increase in the output per man-hour.

b. The relationships among the three factors: physical volume of output, output per man-hour and labor supply, must be as follows:

$$\left.\begin{matrix}\text{Index of Physical Volume of Output}\\ \hline \text{Index of Output per Man-Hour}\end{matrix}\right\} \geqq \text{Index of Labor Supply}$$

c. If the two conditions given above do not obtain, some other compensatory action becomes necessary. Such action might well be in the direction of a curtailment of the standard number of hours per work-week, or a reduction of the number of persons entering the labor market, by means of a withdrawal from the labor market, through legislative means or otherwise, of a number of persons below and above certain age limits.

3. Third, so far as manufacturing industries are concerned, the evidence based on the comparatively short period, 1920–1931, is not conclusive enough to warrant the statement that the increased output per man-hour has resulted in a permanent displacement of workers. In fact, the analysis indicates that during the period 1920–1926 a number *greater* than that displaced by the increased output per man-hour was absorbed by the increased physical volume of output, while the years 1926–1929 failed to absorb only approximately one-tenth of one per cent of those displaced.

4. Although there seems to have been little if any permanent displacement in manufacturing industries, temporary displacement played an important rôle in the fluctuations in employment. During the period 1920–1931, over three million wage earners were displaced because of increases in technological or managerial efficiency, or, an average of about a quarter of a million wage earners a year.

5. This quarter of a million was eventually reabsorbed; some of these workers indeed may never have lost their jobs at all. And yet, if it is recalled that the absorption process took one and one-half years or thereabout to work itself out (see Table V), then the average time lost per displaced worker was approximately three-quarters of a year.[1]

6. Whereas the simultaneous processes, displacement and absorption, tended to cancel each other in the long run when all manufacturing industries are lumped together, this is certainly not the case with individual industries. What was true of railroads and bituminous coal was doubtless also true of a number of manufacturing industries. In order to determine the industries in which the rate of displacement was creating "disemployed" groups of workers it would be necessary to perform this type of analysis for separate industries or groups of industries. Such an investigation should also attempt to determine whether the

[1] Another study on the absorption of displaced workers shows that out of the 754 discharged workers, only 381, or a little over 50 per cent had found jobs in less than nine months of unemployment. See, Isador Lubin, *The Absorption of the Unemployed by American Industry*, The Brookings Institution, Washington, D. C., 1929.

shifting of workers from one industry to another (as a result of displacement and absorption) was predominantly from industries paying comparatively high rates of wages to industries with lower wage levels, or vice versa; whether labor was shifted from industries with a comparatively small number of standard hours per work week to industries with a larger number of full-time hours per week, etc. Furthermore, a study based upon monthly data rather than annual material may well disclose significant relationships which are obscured when yearly figures are used.

7. Finally, the caution bears repeating that, since this study takes neither the mobility of labor (from industries here covered to other industries such as commerce, finance, insurance, personal and professional services, etc.) nor the growth of the population into consideration, conclusions concerning numbers unemployed are unwarranted.

THE EFFECT OF ALLOCATION OF NON-RESIDENT DEATHS UPON OFFICIAL MORTALITY STATISTICS[1]

By Harold F. Dorn

Because of the difficulty of collecting original data, students in the fields of population and vital statistics must rely almost entirely upon the official publications of government agencies. In view of this fact it is unfortunate that official statistics are often published in forms that make them of little value for research purposes or that grossly misrepresent the actual situation. This is particularly true of official vital statistics.

The increasing hospitalization of recent years has attracted many rural and small village residents to the larger, better-equipped urban centers for medical treatment. A considerable number of the births and deaths now occurring in cities, particularly in those with superior hospital and medical facilities, are of non-resident rural people, causing both the birth and death rates of such cities to be unduly increased. On the other hand, the location of sanatoria, and state hospitals and institutions in rural territory markedly affects the recorded vital statistics of such areas. Thus the death rate from tuberculosis may be higher in the country than in the city due to location of sanatoria in rural areas, while the death rate from cancer and appendicitis in the city is probably increased by deaths of rural residents seeking hospital service there. The publication of official vital statistics without correction for residence not only misrepresents the actual situation, but makes such data worthless for detailed research involving areas smaller than states. The Bureau of the Census has very carefully discussed this fact in each of the annual reports of mortality statistics since 1918 but other than publishing the total recorded and resident deaths for the rural and urban parts of each registration state, it has made no corrections in the published data.

Since the pioneering study of Dr. Eichel[2] in New York State in 1919, several individual research projects showing the effect of non-resident deaths on the mortality statistics of selected areas have appeared.[3]

[1] This study was financed by the Scripps Foundation for Research in Population Problems. The data were made available through the courtesy of Mr. I. C. Plummer, Chief of the Division of Vital Statistics, State of Ohio.

[2] O. R. Eichel, "So-Called Non-Resident Deaths—A Preliminary Note on an Experimental Study of This Subject in New York State," *American Journal of Public Health*, IX, 9, 654–662, 1919.

[3] D. G. Wiehl, "The Correction of Infant Mortality Rates for Residence," *American Journal of Public Health*, XIX, 495–510, 1929.

In 1926 the report of the Division of Vital Statistics of New York State contained crude resident and recorded mortality rates for the total population by size of community for all causes of death and for tuberculosis separately. In the 1927 report recorded and resident mortality rates for cancer, automobile accidents allocated to place of occurrence, and infant and maternal mortality were added, and in 1929 deaths from typhoid fever and diphtheria as corrected for the place of contraction of the disease. In addition, DePorte has published articles concerning the effect of non-resident deaths on the mortality rates of certain diseases in New York State.[1]

The above-mentioned studies have dealt either with crude mortality rates for all causes of death, or when the data have been presented by sex or age, only with specific diseases such as tuberculosis. Because of the absence of published mortality rates based on resident deaths and classified by age, sex, color, nativity of whites, and cause of death for different types of communities, this study was undertaken.

The death certificates for the entire state of Ohio for 1930 were searched for deaths of persons who were non-resident of the areas from which the deaths were reported. The data for such deaths were punched on tabulating cards and the death records for the state retabulated on the basis of the residence of the deceased. The tabulation was made by sex, age, color, nativity of whites, and cause of death for the rural population, urban places of 2,500 to 10,000 population, of 10,000 to 100,000 population, and 100,000 population and over for each of the eighty-eight counties of the state. A detailed comparison of the mortality rates based on this classification will be published later, as this report is concerned only with showing the effect of the allocation of non-resident deaths.

It should not be assumed that a resident mortality rate gives a "true" picture of the actual mortality conditions in any place. While recorded rates presuppose that all deaths of non-residents are chargeable to the place of occurrence, resident rates presuppose that none of these deaths is the result of local environment or treatment and that it

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Jean Downes, "The Accuracy of Official Tuberculosis Rates," this JOURNAL, XXVI, 176, 393–406, 1931.

E. H. Pennell, "Deaths of Nonresidents in Syracuse," Milbank Memorial Fund, *Quarterly Bulletin*, X, 3, 212–220, 1932.

Edgar Sydenstricker, "The Trend of Tuberculosis Mortality in Rural and Urban Areas," *American Review of Tuberculosis*, XIX, 461–482, 1929.

[1] J. V. DePorte, "Recorded and Resident Death Rates from Tuberculosis in New York State in 1926," *American Review of Tuberculosis*, XVII, 634–662, 1928.

———, "Extent to Which Residence Influences the Recorded Death Rates from Cancer in the State of New York," *American Journal of Hygiene*, X: 1, 1929.

———, "Some Aspects of the Recorded and Resident Mortality from Tuberculosis in New York State in 1927 and 1928," *American Review of Tuberculosis*, XXII, 87–115, 1930.

would have occurred if the deceased were at home. Obviously this is not strictly true, especially for deaths due to accidental causes, but it is maintained that a resident rate is more representative of the actual mortality conditions than a rate based on recorded deaths.

In the previous studies, the question has been raised as to the method of allocating deaths. DePorte allocated deaths due to automobile accidents to the place of occurrence, deaths due to typhoid fever and diphtheria to the place of contraction of the disease, infant deaths to the residence of the mother, and other deaths to the usual place of abode as stated on the death certificate. Deaths in tuberculosis sanatoria were allocated to the place of residence prior to admittance to the sanatoria.

The rules followed in this study were essentially those adopted by the Bureau of the Census with a few exceptions. Deaths in tuberculosis sanatoria were allocated to the residence of the deceased prior to his admittance to the sanatorium. Because of the absence of health resorts similar to those in the Adirondack Mountains of New York, the problem of the allocation of deaths of temporary residents of such places was not involved. Infant deaths were allocated to the residence of the parents, or to that of the mother in certain cases. Because of the difficulty of deciding the residence of inmates, particularly of those who had been in an institution for five or ten years, deaths in state hospitals and institutions, and county homes and infirmaries were tabulated separately as institutional deaths and were not included in the deaths of the areas in which the institutions were located. Otherwise a non-resident death was defined as a death recorded at a place other than the usual place of abode as stated on the death certificate. In a few cases the resident address was not given and no allocation was made. To be consistent with the census definition of residence followed in population enumeration, it was decided to allocate all deaths to the usual place of abode rather than to distribute deaths to the usual place of abode, place of accident, or contraction of disease. The information necessary for the latter was in most cases lacking and, while there is some question as to where an accidental death should be recorded, it was decided to be consistent with the enumeration of population. An accidental death is not only the result of the immediate environment at the time but also of the habits, reaction time, and physical and mental condition of the person involved, all of which are related to his home environment. Which should receive credit for the death is a moot question.

Deaths of out-of-state residents were discarded. No correction was made for the deaths of Ohio residents occurring in other states. It is

believed that the number of such deaths was not large because of the absence of large cities near the Ohio border in adjoining states, with the possible exception of Wheeling and Huntington, West Virginia. Due to the location of Cincinnati, Cleveland, and Toledo, all near the state line, Ohio probably draws many more residents from other states than the adjacent states draw from Ohio.

The allocation of non-resident deaths was not perfect for rapidly growing cities and for cities separated only by a political boundary. Around a rapidly growing city, streets often are extended beyond the city boundaries. When the street address was given and no indication as to whether or not the residence was within the city boundary or outside, the death was credited to the city as recorded. In this way a few deaths of rural persons (as defined by the census) were included in the urban population, but since these were in reality residents of the city it is believed no bias was introduced into the data. Difficulties also arose where a suburb was located immediately adjacent to a larger city as, for example, Bexley adjoining Columbus, where only a political boundary separates the two places. In some instances the proper city was not indicated on the death certificate, only the street address being given. In this way some deaths of residents of suburban areas were probably included among the deaths of the larger city; but upon checking the number of deaths in these smaller places, it is very doubtful if the number was large.

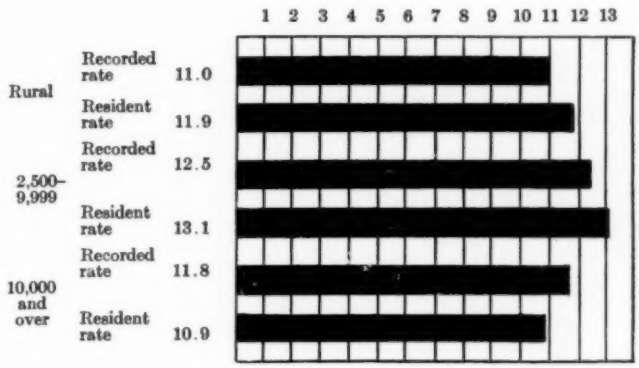
Such cases are mentioned, not because they are a large proportion of the number of cases, but because they illustrate the difficulty of determining what is and what is not a non-resident death, and what is to be done with it after it has been discovered. In spite of these difficulties and the slight inaccuracies due to them, the resultant resident mortality rate is doubtless more representative of the prevailing conditions than the original recorded rate.

The allocation of deaths was by primary registration districts; that is, townships, incorporated villages, and cities. Consequently the deaths allocated to rural territory did not all occur in urban territory but may have occurred in a different rural township of the same county or of a different county. The same applies to each of the different sized communities. This gives the true number of non-resident deaths, but means that deaths were both added to and subtracted from many of the areas.

Of the 76,216 deaths recorded in Ohio in 1930, 6,731 or 9 per cent were non-resident of the primary registration areas from which they were reported, and 922 or 14 per cent of the non-resident deaths were of residents of other states. The distribution of non-resident deaths was

CHART I

RECORDED AND RESIDENT CRUDE DEATH RATES PER 1,000 TOTAL POPULATION FOR THE RURAL POPULATION AND CITIES OF 10,000 POPULATION AND OVER, AND PER 1,000 NATIVE WHITE POPULATION FOR URBAN PLACES OF 2,500–9,999 POPULATION; OHIO, 1930



very unequal throughout the state. In some of the more rural areas where it is several miles to hospital facilities, the number of non-resident deaths was small, while around the large cities the number was large. In Hamilton County where Cincinnati is located, the number of deaths allocated to the rural part of the county was 48 per cent of the total number of deaths recorded in rural territory; in Cincinnati 12 per cent of the recorded deaths were non-resident. After deducting the deaths due to the Ohio penitentiary fire, 15 per cent of the recorded deaths in Columbus were non-resident; in Toledo 10 per cent of the recorded deaths were non-resident, while the deaths allocated to the rural part of the county (in which Toledo is located) were 30 per cent of the total recorded deaths. Although these are some of the extreme instances, they serve to indicate the extent of the problem in certain areas.

Chart I shows the recorded and resident mortality rates per 1,000 total population for the rural population, places of 2,500 to 10,000 population, and cities of 10,000 population and over. It should be remembered that crude rates are very unreliable indices for comparison of communities with unlike age, sex, nationality, racial, and occupational composition. Specific age, sex, and nativity rates will be presented later, but the crude rates show the differences due to allocation of non-resident deaths. Whereas the rural rate was increased about 8 per cent and the rate for places of 2,500 to 10,000 population increased about 5 per cent, the rate for the cities of 10,000 population or over was *decreased* about 8 per cent.

The resident rate was higher than the recorded rate for the rural

TABLE I

RECORDED AND RESIDENT DEATHS AND DEATH RATES PER 100,000 TOTAL POPULATION FOR SELECTED CAUSES OF DEATH, OHIO, 1930

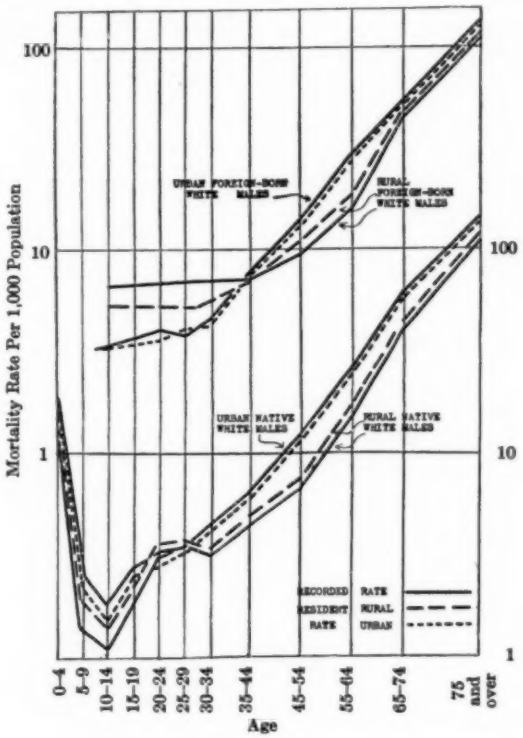
International list number, 1929 revision	Cause of death	Urban					Rural				
		Number of recorded deaths†	Number of resident deaths†	Recorded rate	Resident rate	Per cent change	Number of recorded deaths†	Number of resident deaths†	Recorded rate	Resident rate	Per cent change
11, 107, 108, 109	Influenza, pneumonia (all forms)	4,284	4,079	95.0	90.5	− 5	1,943	2,111	90.8	98.7	+ 9
23–32	Tuberculosis (all forms)	2,688	2,866	59.6	63.6	+ 7	1,243	1,028	58.1	48.1	− 17
45–53	Cancer (all forms)	4,973	4,678	110.3	103.8	− 6	1,974	2,190	92.3	102.4	+ 11
59	Diabetes mellitus	1,064	997	23.6	22.1	− 6	365	418	17.1	19.5	+ 14
82	Cerebral hemorrhage, embolism, and thrombosis	4,339	4,226	96.3	93.8	− 3	2,609	2,683	122.0	125.4	+ 3
90–95	Heart disease	9,854	9,590	218.6	212.8	− 3	4,575	4,729	213.9	221.1	+ 3
117, 118	Ulcers and other diseases of stomach and duodenum	469	407	10.4	9.0	−13	157	209	7.3	9.8	+ 34
119, 120	Diarrhea and enteritis	964	891	21.4	19.8	− 7	500	549	23.4	25.7	+ 10
121	Appendicitis	950	742	21.1	16.5	−22	64	245	3.0	11.5	+283
122, 123	Hernia and other diseases of intestines	664	545	14.7	12.1	−18	107	210	5.0	9.8	+ 96
124–127	Diseases of liver and gall bladder	614	532	13.6	11.8	−13	237	304	11.1	14.2	+ 28
130–133	Nephritis, and other diseases of kidneys and ureters	3,734	3,569	82.8	79.2	− 4	1,580	1,704	73.9	79.7	+ 8
140–150	Diseases of pregnancy, childbirth, and puerperal state	570	459	6.7*	5.8*	−13	113	208	3.3*	5.5*	+ 67
163–175	Suicides, homicides	1,346	1,278	29.9	28.4	− 5	436	455	20.4	21.3	+ 4
210	Automobile accidents (primary)	1,604	1,384	35.6	30.7	−14	472	584	22.1	27.3	+ 24
176 and over	Accidents, excluding automobile	3,085	2,812	68.4	62.4	− 9	1,429	1,602	66.8	74.9	+ 12

* Rate per 1,000 live births. Data for births taken from an unpublished tabulation by Mr. P. G. Beck of Ohio State University in coöperation with Scripps Foundation for Research in Population Problems.

† Exclusive of institutional deaths.

CHART II

RECORDED AND RESIDENT DEATH RATES PER 1,000 POPULATION FOR NATIVE AND FOREIGN-BORN WHITE MALES, RURAL AND URBAN, OHIO, 1930

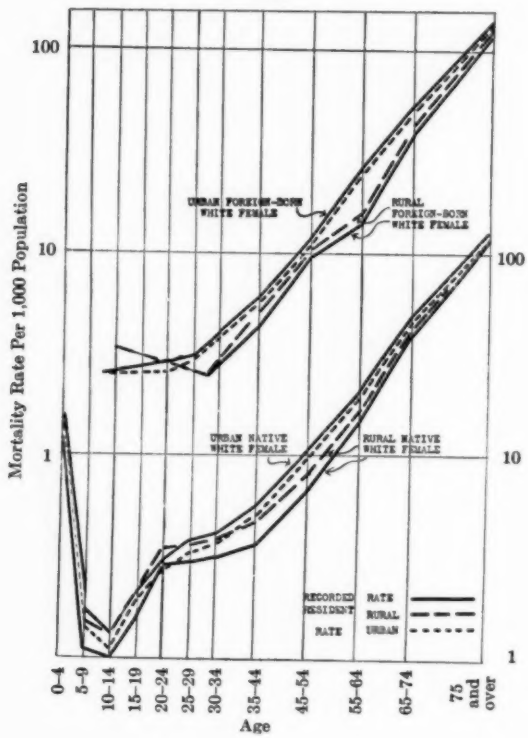


population of 85 of the 88 counties. The higher recorded rate in the rural part of two of the counties was due to the location of tuberculosis sanatoria, while that for the third was due to a rural hospital. In the majority of the places of 2,500 to 10,000 population the resident rate was higher than the recorded rate, but in some, especially where such places were the only urban places in the county and had the only hospital, the recorded rate was higher. With only three exceptions, the resident rate of the cities of 10,000 population or over was lower than the recorded rate.

The inaccuracy of the recorded rates for specific diseases is clearly shown by Table I which gives the differences between the recorded and resident rates for several diseases and groups of diseases in rural and urban communities. It should be remembered that the differences in the urban rates are lessened somewhat by the inclusion of places of

CHART III

RECORDED AND RESIDENT DEATH RATES PER 1,000 POPULATION FOR NATIVE AND FOREIGN-BORN WHITE FEMALES, RURAL AND URBAN, OHIO, 1930



2,500 to 10,000 population; but even so, the changes are marked. The rates shown are crude rates, so that the differences between the urban and rural rates may be reversed when corrected for age, sex, and nativity; but the recorded and resident rates for the same community can be fairly compared. With the exception of tuberculosis, each of the resident rates for the rural population is higher than the recorded rate, the percentage increase ranging from 4 per cent for suicide and homicide to 283 per cent for appendicitis. For the important diseases the increases were 8 per cent for nephritis and other diseases of the kidneys and ureters, 12 per cent for accidental deaths exclusive of automobile accidents, 11 per cent for cancer, and 9 per cent for influenza and pneumonia. In contrast to these increases the rate for tuberculosis was *decreased* 17 per cent.

The changes in the urban rates were the direct opposite of those for

the rural, the resident rates being lower than the recorded rates for all the diseases except tuberculosis for which the recorded rate was *increased* 7 per cent. The percentage differences for the urban rates were somewhat less than those for the rural rates, ranging from a decrease of 3 per cent for heart disease and cerebral hemorrhage to a decrease of 22 per cent for appendicitis. The largest decreases were in the rates for automobile accidents, diseases of the liver and gall bladder, hernia and other diseases of the intestines, appendicitis, ulcers and other diseases of the stomach and duodenum, and diseases of pregnancy, childbirth, and puerperal state.

Rates, both recorded and resident, have been computed by nativity of white and by color but, since these show that most of the difference between the recorded and resident rates is due to the native white deaths, they are not presented here. The rural foreign-born white and colored rates changed much more than the native white rate for tuberculosis, the decreases being 33, 55, and 10 per cent respectively. The important differences for the rural foreign-born white population were increases of 11 per cent in the rate for cancer, 21 per cent for diabetes mellitus, and 10 per cent for nephritis and other diseases of the kidneys and ureters. Except for increases of 14 per cent in the rate for cerebral hemorrhage, 9 per cent in the rate for heart disease, and 17 per cent in the rate for accidental deaths there was practically no change in the rates for the rural colored population. The changes in the rates for the rural native white population correspond very closely to those in the rates for the total population. The same general considerations are also true for the urban native white, foreign-born white, and colored populations.

The allocation of births and infant deaths to the residence of the mother increases the disparity between the infant mortality rates of rural and urban areas (Table II). The recorded rural white infant

TABLE II

RECORDED AND RESIDENT DEATHS UNDER ONE YEAR OF AGE AND INFANT MORTALITY RATES, BY COLOR, FOR THE RURAL AND URBAN POPULATION, OHIO, 1930 *

	White		Colored		White		Colored	
	Recorded rate	Resident rate	Recorded rate	Resident rate	Number of recorded deaths	Number of resident deaths	Number of recorded deaths	Number of resident deaths
Urban.....	58.2	57.3	104.4	102.9	4,531	4,241	589	578
Rural.....	60.2	61.0	88.4	98.0	2,022	2,261	49	58

* Recorded and resident births taken from an unpublished tabulation made by Mr. P. G. Beck of Ohio State University in coöperation with the Scripps Foundation for Research in Population Problems.

TABLE III

RECORDED AND RESIDENT DEATHS AND DEATH RATES PER 1,000 POPULATION BY AGE, SEX, COLOR, AND NATIVITY OF WHITE, FOR THE RURAL POPULATION, OHIO, 1930 *

Age	White								Colored			
	Native †				Foreign born				Male		Female	
	Male		Female		Male		Female					
	Recorded	Resident	Recorded	Resident	Recorded	Resident	Recorded	Resident	Recorded	Resident	Recorded	Resident
	Numbers											
0– 4	1,479	1,671	1,191	1,338					37	50	25	27
5– 9	161	215	121	162								
10–14	127	163	106	139	21	17	9	9	14	17	2	4
15–19	185	223	148	185								
20–24	245	285	193	232					40	24	37	22
25–29	222	234	183	221								
30–34	195	210	189	232	38	28	13	13	48	37	16	5
35–44	531	594	419	552	91	90	41	47	53	48	22	21
45–54	723	824	668	811	123	145	85	91	44	49	23	26
55–64	1,330	1,489	1,143	1,285	136	157	82	91	45	45	20	19
65–74	2,408	2,587	1,956	2,048	240	258	148	153	43	45	20	21
75 and over	2,813	2,926	2,846	2,895	334	347	307	309	41	43	32	33
Total	10,419	11,421	9,163	10,100	983	1,042	685	713	365	358	197	178
	Rates											
0– 4	14.6	16.5	12.3	13.8					20.9	28.2	13.8	14.9
5– 9	1.4	1.9	1.1	1.5								
10–14	1.1	1.4	1.0	1.3	6.6	5.3	3.3	3.3	3.7	4.4	1.0	1.1
15–19	1.8	2.2	1.6	2.1								
20–24	3.1	3.6	2.8	3.4					9.9	5.9	12.5	7.4
25–29	3.5	3.7	3.0	3.6								
30–34	3.1	3.4	3.1	3.8	7.1	5.2	2.4	2.4	14.6	11.3	6.5	2.0
35–44	4.3	4.9	3.5	4.7	7.1	7.0	4.2	4.9	18.1	16.4	10.1	9.6
45–54	6.6	7.6	6.6	8.0	9.6	11.3	9.9	10.6	18.6	20.7	14.5	16.4
55–64	15.0	16.8	14.7	16.6	16.4	18.9	14.2	15.8	31.2	31.2	21.2	20.2
65–74	40.8	43.8	38.5	40.3	43.4	46.6	39.3	40.7	49.6	51.9	36.4	38.2
75 and over	113.3	117.8	119.6	121.7	114.6	119.0	128.1	128.9	94.9	99.5	107.0	110.4
Total	10.0	11.0	9.5	10.5	19.2	20.4	17.9	18.6	17.4	17.0	11.9	10.8
Adjusted Rate ‡		8.7		8.3		9.5		7.7		15.9		10.3

* Excluding institutional deaths. The population has been corrected for residents of state hospitals and homes for the feeble-minded and epileptic.

† Includes whites of unknown nativity.

‡ Based on the standard million population of England and Wales, 1901.

mortality rate was 3 per cent higher than the corresponding urban rate, while the resident rural white infant mortality rate was 6 per cent greater than the resident urban rate. The resident mortality rate for rural colored infants is lower than the corresponding urban rate, but the number of births and deaths is rather small to give conclusive evidence. These differences are in general agreement with the findings of DePorte in New York State where the rural resident infant mortality

TABLE IV

RECORDED AND RESIDENT DEATHS AND DEATH RATES PER 1,000 POPULATION BY AGE, SEX, COLOR, AND NATIVITY OF WHITE, FOR THE URBAN POPULATION, OHIO, 1930 *

Age	White								Colored			
	Native †				Foreign born							
	Male		Female		Male		Female		Male		Female	
	Recorded	Resident	Recorded	Resident	Recorded	Resident	Recorded	Resident	Recorded	Resident	Recorded	Resident
	Numbers											
0- 4	3,246	3,006	2,562	2,375					424	409	346	344
5- 9	485	419	315	265	41	41	32	32	44	43	41	40
10-14	318	275	235	199					33	32	39	38
15-19	470	408	385	341					69	79	91	98
20-24	553	484	570	507	53	48	39	35	131	132	145	151
25-29	544	501	593	535	81	82	63	61	172	172	147	151
30-34	624	584	572	522	132	122	108	106	216	219	182	187
35-44	1,620	1,470	1,394	1,227	677	665	372	356	460	459	374	373
45-54	2,205	2,031	1,952	1,776	977	947	583	565	499	491	342	338
55-64	2,978	2,765	2,519	2,336	1,089	1,062	802	787	299	300	200	199
65-74	3,469	3,231	3,251	3,120	1,098	1,070	1,011	998	183	180	178	174
75 and over	2,782	2,645	3,334	3,251	1,075	1,054	1,311	1,301	121	120	121	121
Total	19,294	17,819	17,682	16,454	5,223	5,091	4,321	4,241	2,651	2,636	2,206	2,214
	Rates											
0- 4	18.5	17.1	15.1	14.0					34.3	33.1	27.4	27.2
5- 9	2.5	2.2	1.7	1.4	3.3	3.3	2.5	2.5	3.5	3.4	3.1	3.0
10-14	1.8	1.5	1.3	1.1					3.3	3.2	3.7	3.6
15-19	2.8	2.5	2.1	1.9					7.3	8.4	8.3	9.0
20-24	3.3	2.8	3.1	2.7	4.1	3.7	2.8	2.5	10.3	10.4	10.4	10.8
25-29	3.5	3.2	3.7	3.3	3.9	4.0	3.0	2.9	10.6	10.6	9.1	9.4
30-34	4.4	4.1	4.0	3.6	4.5	4.2	4.0	3.9	14.2	14.4	13.3	13.6
35-44	6.5	5.9	5.5	4.8	7.5	7.4	5.7	5.5	16.9	16.8	16.6	16.6
45-54	12.3	11.4	10.6	9.6	14.2	13.8	11.5	11.1	30.9	30.4	27.6	27.3
55-64	26.6	24.7	20.7	19.2	29.4	28.7	25.2	24.7	46.5	46.7	38.3	38.1
65-74	61.5	57.3	46.6	44.7	53.2	51.8	50.9	50.2	80.5	79.2	77.3	75.5
75 and over	146.0	138.8	122.1	119.0	138.1	135.4	135.4	134.4	135.7	134.5	110.8	110.8
Total	10.7	9.9	9.5	8.8	17.0	17.0	17.1	16.8	18.7	18.6	16.4	16.4
Adjusted Rate ‡		10.4		8.6		9.8		8.5		20.3		18.3

* Excluding institutional deaths. The population has been corrected for residents of state hospitals and homes for the feeble-minded and epileptic.
† Includes whites of unknown nativity.
‡ Based on the standard million population of England and Wales, 1901.

rate was higher than the urban resident infant mortality rate for both 1929 and 1930.[1]

The discrepancy between the recorded and resident rates is further illustrated by the age specific rates for the native white, foreign-born white and colored populations. The general tendency is to decrease the difference between the rural and urban groups. Whereas the recorded deaths show that the mortality rates at all ages are less for rural

[1] New York State Department of Health, *Fifty-First Annual Report*, Vol. 2, pp. lxxix–xciv, 1930.

than urban native white males, the resident rates for age groups, 20–24 and 25–29, are less for the urban than for the rural. Considering the native white females, we find that the relative standing is again reversed for the age groups from 5 to 35 years, the resident urban rates being less than the resident rural rates for this period while the recorded rates show the opposite to be true. For the other ages the resident rural rates are less than the resident urban rates except for the ages above 75 years for the native white females.

While the urban rates are lower than the rural rates in the younger age groups for the foreign-born white males and females, due to the small number of deaths in the rural population no definite conclusions can be drawn. During the adult and old age groups the resident rural rates are lower than the resident urban rates.

Due primarily to the allocation of deaths from tuberculosis the resident rates for the urban colored males and females are higher than the recorded rates from ages 5 to 35 years. This makes the difference between the mortality rates for the rural and urban colored populations even greater than shown by the recorded rates. For the remainder of the age groups the effect of the allocation of non-resident deaths is to decrease the difference between the rural and urban rates, with the rural resident rates less than the urban resident rates, although here again the number of deaths in the rural population is too small to warrant definite conclusions for the younger age groups.

These data should make perfectly evident the unreliability of conclusions drawn from recorded mortality statistics when comparing areas smaller than states as a whole. Since the difference between the recorded and resident rates varies for different causes of death, for the two sexes, and for the separate nativity and racial groups there seems to be no alternative except to tabulate mortality statistics by residence of the deceased, if one wishes to avoid misinterpretation of the data.

SUMMATION METHODS IN FITTING PARABOLIC CURVES

By Frederick F. Stephan

In spite of the labor-saving methods and tables which are available, fitting parabolic trend lines to time series of any length is still a tedious process and the statistical computer is tempted to check only part of the calculations. This article presents a further development of accepted methods which saves time and labor in computation but which is especially designed to facilitate the proper checking of the whole process.[1]

The procedure here outlined is applicable to any series of points uniformly spaced along the horizontal scale, i.e., to any set of equidistant ordinates. It provides parabolic curves, fitted by least squares, of any desired degree up to the fifth: $Y=a+bx+cx^2+dx^3+ex^4+fx^5$. Curves of all lower degrees are secured as by-products. Its applicability to time series should give it a wide field of usefulness.

The advantages of the new procedure are several. It assigns the bulk of the work to the adding machine rather than to the calculator. The adding machine tape furnishes a quick and reliable check on this part of the computations. In the few remaining calculations, simple and direct formulas are substituted for the customary solution of "normal equations." Because of the directness of these calculations the computer can determine quite readily the number of significant figures to be retained. He can also tell at a glance approximately what the resultant values will be and thereby secure a rough but handy check on the latter part of the computations.

The quantities involved in the formulas are smaller, especially for an even number of ordinates, than those which are encountered in the usual methods. On the whole, the procedure requires fewer and simpler operations than the Doolittle Method, generally conceded to be the simplest of the well-known methods. The margin of advantage varies with the data and is greatest when a large and even number of ordinates is fitted with a parabola of third or higher degree.

[1] Various phases of the methods here presented are to be found in the following references: R. W. Burgess, *Introduction to the Mathematics of Statistics*, 162–6 and 294–5; B. H. Camp, *The Mathematical Part of Elementary Statistics*, 106–8; H. T. Davis and V. V. Latshaw, "Formulas for the Fitting of Polynomials to Data by the Method of Least Squares," *Annals of Mathematics*, Second Series, 31 (1930), 52–78; W. P. Elderton, *Frequency Curves and Correlation*, 22–3; L. Isserlis, "Note on Cheby-sheff's Interpolation Formula," *Biometrika*, XIX (1927), 87–93; K. Pearson, *Tables for Statisticians and Biometricians*, xlvi–xlix and Table XXVII; E. C. Rhodes, "On the Fitting of Parabolic Curves to Statistical Data," *Journal of the Royal Statistical Society*, XCIII (1930), 569–573; Frank Ross, "Formulae for Facilitating Computations in Time Series Analysis," this Journal, XX (1925), 75–9; and E. T. Whitaker and G. Robinson, *The Calculus of Observations*, 291–7.

The procedure is actually less complicated than it first appears to a reader who is not familiar with summation methods. It consists of three stages, the adding machine work or "summation processes," the computation of the constants or parameters of the equation from formulas, and the determination of points on the curve from the equation. These stages will be described in order.

THE SUMMATION PROCESSES

The values to be derived from the data for use in the formulas are secured through repeated adding or summation. The summations start at each end of the Y-series and progress to its center. They can be performed very readily on any adding machine with a subtotal key. *Only as many steps should be taken in the following and later sections as are required by the degree of the curve being fitted.*

1. List the Y-values in the order of decreasing values of X. Let N be the number of Y-values in the series. Let P be $\frac{1}{2}N$ if N is even and $\frac{1}{2}(N-1)$ if N is odd. Determine N and P.

2. Starting with the first item (that which corresponds with the highest value of X) proceed to add the Y-series. Take a subtotal after each item, including the first. Continue until P items have been added. A series of subtotals is thus secured. Term this series the *upper first summation.*

3. Starting with the last item (that which corresponds to the lowest value of X) proceed to add the lower part of the Y-series in similar fashion but moving upwards. Term this series of subtotals the *lower first summation.*

4. Starting with the first subtotal of the upper first summation proceed to add the series of subtotals taking a new subtotal after each, including the first. This produces a new series of subtotals. Term it the *upper second summation.* In like manner summate the series of subtotals of the lower first summation.

5. Repeat this procedure using the new series of subtotals to obtain a third summation for each half of the data, summating the third series of subtotals to get a fourth summation, and so on. Continue until there are as many summations as there are parameters in the desired curve, e.g., for a cubic or third degree parabola, four summations of each half of the data are required.

A typical problem involving four summations is presented in Table I. A section of the adding machine tape for the third summation is also shown. Subtotals need not be taken during the last summation if a total is taken off at the proper point as explained below. Each summation should be checked before the next is performed.

TABLE I

BUSINESS FAILURES IN THE UNITED STATES, 1897–1921 *

Year	x	Number of failures Y	Summations			
			First	Second	Third	Fourth
1921	+12	19,982	19,982	19,982	19,982	19,982
1920	+11	8,463	28,445	48,427	68,409	88,391
1919	+10	5,515	33,960	82,387	150,796	239,187
1918	+ 9	9,331	43,291	125,678	276,474	515,661
1917	+ 8	13,073	56,364	182,042	458,516	974,177
1916	+ 7	16,498	72,862	254,904	713,420	1,687,597
1915	+ 6	19,035	91,897	346,801	1,060,221	2,747,818
1914	+ 5	16,780	108,677	455,478	1,515,699	4,263,517
1913	+ 4	14,553	123,230	578,708	2,094,407	6,357,924
1912	+ 3	13,832	137,062	715,770	2,810,177	9,168,101
1911	+ 2	12,679	149,741	865,511	*3,675,688*	*12,843,789*
1910	+ 1	11,588	*161,329*	*1,026,840*	*4,702,528*	
1909	0	*11,872*				
1908	− 1	14,066	*128,757*	*838,756*	*3,988,384*	
1907	− 2	10,274	114,691	709,999	*3,149,628*	*11,228,277*
1906	− 3	9,385	104,417	595,308	2,439,629	8,078,649
1905	− 4	9,967	95,032	490,891	1,844,321	5,639,020
1904	− 5	10,417	85,065	395,859	1,353,430	3,794,699
1903	− 6	9,775	74,648	310,794	957,571	2,441,269
1902	− 7	9,973	64,873	236,146	646,777	1,483,698
1901	− 8	10,648	54,900	171,273	410,631	836,921
1900	− 9	9,912	44,252	116,373	239,358	426,290
1899	−10	9,642	34,340	72,121	122,985	186,932
1898	−11	11,615	24,698	37,781	50,864	63,947
1897	−12	13,083	13,083	13,083	13,083	13,083

* These data are taken from F. C. Mills, *Statistical Methods*, 284–290. By referring to Mills, the reader may compare the methods proposed here with the usual methods employed. Note that Mills does not show all the details of computation. Note also that if he had taken n to be even, the size of the numbers involved would have been increased considerably.

SECTION OF ADDING MACHINE TAPE FOR LOWER THIRD SUMMATION

13,083 *

13,083 S
37,781

50,864 S
72,121

122,985 S
116,373

239,358 S

The results of the summations should be taken from the tapes for use in the formulas for the parameters of the curve.

If N is even, calculate T-values as follows:

T_1 is the sum of the Pth subtotals in the upper and lower first summations;

T_2 is the sum of the Pth and $(P-1)$th subtotals in the upper second summation *minus* the sum of the Pth and $(P-1)$th subtotals in the lower second summation;

T_3 is the sum of the $(P-1)$th subtotals in the upper and lower third summations;

T_4 is the sum of the $(P-1)$th and $(P-2)$th subtotals in the upper fourth summation *minus* the sum of the $(P-1)$th and $(P-2)$th subtotals in the lower fourth summation;

T_5 is the sum of the $(P-2)$th subtotals in the upper and lower fifth summations; and

T_6 is the sum of the $(P-2)$th and $(P-3)$th subtotals in the upper sixth summation *minus* the sum of the $(P-2)$th and $(P-3)$th subtotals in the lower sixth summation.

If N is odd, calculate T-values as follows:

T_1 is the sum of the Pth subtotals in the upper and lower first summation *plus* the central or $(P+1)$th item of the Y-series;

T_2 is the Pth subtotal in the upper second summation *minus* the Pth subtotal in the lower second summation;

T_3 is the sum of the Pth and $(P-1)$th subtotals in the upper third summation *plus* the sum of the Pth and $(P-1)$th subtotals in the lower third summation;

T_4 is the $(P-1)$th subtotal in the upper fourth summation *minus* the $(P-1)$th subtotal in the lower fourth summation;

T_5 is the sum of the $(P-1)$th and $(P-2)$th subtotals in the upper fifth summation *plus* the sum of the $(P-1)$th and $(P-2)$th subtotals in the lower fifth summation; and

T_6 is the $(P-2)$th subtotal in the upper sixth summation *minus* the $(P-2)$th subtotal in the lower sixth summation.

The procedure in making up these values may be illustrated from the data of Table I where the required subtotals are printed in italics.

		4,702,528	
161,329		3,675,688	
11,872	1,026,840	3,988,384	12,843,789
128,957	− 838,756	3,149,628	−11,228,277
T_1 = 301,958	T_2 = 188,084	T_3 = 15,516,228	T_4 = 1,615,512

If data for 1921 are excluded, making N even, the summations are altered. Table II shows the central portion of the new summation series. Values for the formulas now become:

	940,275		10,272,869
	787,056		7,128,937
128,757	− 838,756	3,143,932	−11,228,227
153,219	− 709,999	3,149,628	− 8,078,649
T_1 = 281,976	T_2 = 178,576	T_3 = 6,293,560	T_4 = − 1,905,120

These T-values with K-values taken from Table III are inserted in formulas for the calculation of the desired parameters.

TABLE II

BUSINESS FAILURES IN THE UNITED STATES, 1897–1920

Year	x	Number of failures Y	Summations			
			First	Second	Third	Fourth
1920	+11.5	8,463	8,463	8,463	8,463	8,463
1919	+10.5	5,515	13,978	22,441	30,904	39,367
....	....	....	....	....	....	....
1911	+ 2.5	12,679	129,759	645,709	2,356,876	*7,128,937*
1910	+ 1.5	11,588	141,347	*787,056*	*3,143,932*	*10,272,869*
1909	+ 0.5	11,872	*153,219*	*940,275*	....	....
1908	− 0.5	14,066	*128,757*	*838,756*	....	....
1907	− 1.5	10,274	114,691	*709,999*	*3,149,628*	*11,228,277*
1906	− 2.5	9,385	104,417	595,308	2,439,629	*8,078,649*
....	....	....	....	....	....	....

FORMULAS FOR THE PARAMETERS OF THE FITTED CURVE

If x is a value of the X variable measured in units of one interval between ordinates and from the midpoint between the first and last ordinates, if T-values are taken as defined above, and if K-values are derived from Table III, then the parameters of the curve $Y=a+bx+cx^2+\ldots$ fitted to the Y-series by least squares are as follows:[1]

Parameter	Formula	
	N is even	N is odd
a_1	$\frac{T_1}{N}$	$\frac{T_1}{N}$
$b_1=b_2$	$\frac{T_2}{K_1}$	$\frac{2T_2}{K_1}$
$c_2=c_3$	$\frac{6T_3-K_2T_1}{K_3}$	$\frac{3T_3-K_3T_1}{K_3}$
$d_3=d_4$	$\frac{10T_4-K_3T_2}{2{,}000{,}000K_7}$	$\frac{10T_4-(K_3-2)T_2}{1{,}000{,}000K_7}$
$e_4=e_5$	$\frac{280T_5+(K_5-3)\ (K_5T_1-20T_3)}{1{,}000{,}000K_9}$	$\frac{140T_5+(K_5-2)\ (K_5T_1-10T_3)}{1{,}000{,}000K_9}$
f_5	$\frac{504T_6-(7K_4-105)T_4+K_5(K_5-3)T_2}{2{,}000{,}000K_{10}}$	$\frac{504T_6-(7K_4-168)T_4+(K_5-2)\ (K_5-6)T_2}{1{,}000{,}000K_{10}}$

The subscript of each parameter indicates the degree of the curve in which it may be used. Calculate only those parameters required by curves of the degree desired and lower degrees. The remaining param-

[1] Note that when N is even, the denominators for d_3 and f_5 are double those used when N is odd.

eters of the desired curve are obtained from the parameters for curves of lower degree by the following formulas:

$$a_2 = a_3 = a_1 - \frac{K_4 c_2}{12}; \qquad a_4 = a_5 = a_2 + \frac{K_4}{40}\left[\frac{K_2 - 20}{14} e_4\right]$$

$$b_3 = b_4 = b_1 - \frac{K_2 d_3}{20}; \qquad c_4 = c_5 = c_2 - \left[\frac{K_2 - 20}{14} e_4\right] - e_4$$

$$b_5 = b_3 + 5K_8 f_5; \qquad d_5 = d_3 - \frac{(10K_4 - 60) f_5}{36}$$

Note that in calculating a_4 and c_4 the portion of each equation enclosed in brackets is common to the two equations and need be calculated but once.

The use of these formulas in computing the parameters of the fitted curve may be illustrated from the data of Table I. Assuming that five significant figures are needed:[1]

$$a_1 = \frac{301{,}958}{25} = 12{,}078 \qquad b_1 = b_2 = \frac{2(188{,}084)}{2{,}600} = 144.68$$

$$c_2 = c_3 = \frac{3(15{,}516{,}228) - 156(301{,}958)}{161{,}460} = -3.4483$$

$$d_3 = \frac{10(1{,}615{,}512) - 154(188{,}084)}{3{,}652{,}120} = -3.5075$$

$$a_2 = a_3 = 12{,}078 - \frac{624}{12}(-3.448) = 12{,}257$$

$$b_3 = 144.68 - \frac{1{,}868}{20}(-3.5075) = 472.28$$

The resulting curves and equations are:[2]

$$Y = 12{,}078 + 144.68x$$
$$Y = 12{,}257 + 144.68x - 3.448x^2$$
$$Y = 12{,}257 + 472.28x - 3.448x^2 - 3.5075x^3$$

where x is "years since 1909" and Y is the number of failures in one year.

[1] The difference between two quantities of nearly equal size is not accurate to as many significant figures as either of the original quantities. This source of inaccuracy, which should be watched in the numerators of the formulas, is equally but more subtly present in the solution of normal equations.

[2] It will be noted that these methods require the computation of parameters for all curves up to the degree of that sought. Hence the comparison of these curves of lower degree with the curve specifically being fitted is fostered and the selection of a curve of higher degree than necessary is discouraged.

The following formulas may be used to check the parameters as calculated from the formulas:

$$K_1\left(a_2+\frac{K_2c_2}{20}\right)=\begin{cases}4T_3+\frac{1}{2}T_1 & \text{(if } N \text{ is even)}\\ 2T_3 & \text{(if } N \text{ is odd)}\end{cases}$$

$$K_1\left(\frac{K_2b_3}{20}+\left[9K_8+\frac{K_4}{4}-\frac{1}{5}\right]d_3\right)=\begin{cases}6T_4+\frac{1}{4}T_2 & \text{(if } N \text{ is even)}\\ 12T_4+2T_2 & \text{(if } N \text{ is odd)}\end{cases}$$

$$2Na_4+K_1\left(c_4+\frac{K_2e_4}{20}\right)=2T_1$$

$$K_1\left(b_5+\frac{K_2d_5}{20}+\left[9K_8+\frac{K_4}{4}-\frac{1}{5}\right]f_5\right)=\begin{cases}T_2 & \text{(if } N \text{ is even)}\\ 2T_2 & \text{(if } N \text{ is odd)}\end{cases}$$

CALCULATION OF THEORETICAL Y-VALUES FROM THE FITTED CURVE

Points on the fitted curve corresponding to given x-values may be calculated by summation methods similar to those used in fitting the curve itself. Set up for summation a column the items of which are derived from the parameters of the curve as follows:

Item in column	Formulas for column entries	
	When N is even	When N is odd
First	120f	120f
Second	24e−180f	24e−120f
Third	6d−24e+ 75f	6d−12e+ 30f
Fourth	2c− 3d+ 5e−15½f	2c +2e
Fifth	b +¼d +⅛f	b+ c+ d +e +f
Sixth	a+½b+¼c+⅛d+1/16e+1/32f	a+b+ c+ d +e +f

Disregard any parameters which appear only in curves of higher degree than that fitted. The column will then contain as many entries not equal to zero as there are parameters in the curve. The first item will be $120f_5$ for a fifth degree curve, $24e_4$ for a fourth degree curve, $6d_3$ for a third degree curve, etc.

Summate the resulting column in exactly the same manner as the Y-series except that each summation is carried all the way down the column instead of stopping at the middle. Repeat the summations P times. The sixth or lowest line will then contain computed Y-values for $x=+\frac{1}{2}, +\frac{3}{2}, +\frac{5}{2}, \ldots +(P+\frac{1}{2})$, when N is even, and for $x=+1, +2, +3, +4, \ldots +P$, when N is odd.

These summations may well be performed on the adding machine. Negative items can be handled readily by the usual procedure of subtracting them from the next higher power of 10 and prefacing as many 9's as the keyboard will accommodate. Thus an item of −3.448 be-

comes 99,996.552 on an eight place machine. This number is then added in the summations as a positive number. *Due regard must be given to the position of the decimal point.*

To obtain computed Y-values for negative values of x, set up a second column like the first except that the signs of b, d and f are reversed in the formulas from which the items are calculated, and summate in the same manner as before. To check the summations calculate independently the Y-values for $x=+\frac{1}{2}(N-1)$ and for $x=-\frac{1}{2}(N-1)$.

If a large number of Y-values are to be computed it may be more convenient to carry the summation processes horizontally, adding horizontally line by line instead of vertically column by column. In either case the rule is that any item is the sum of the item immediately above it in the same column and the item immediately to the left of it on the same line.

TABLE III

CONSTANTS TO BE USED IN FORMULAS FOR PARAMETERS OF PARABOLIC CURVES

N	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	N
6	35	101	112	35	8		.000 108	2.295 040	.000 560	.000 240	6
7	56	140	252	48	12		.000 360	4.990 476	.005 280	.002 880	7
8	84	186	504	63		15	.000 990	9.350 595	.021 120	.019 720	8
9	120	236	924	80	20		.002 376	15.911 111	.068 640	.087 360	9
10	165	293	1 584	99		24	.005 148	25.279 167	.192 192	.327 600	10
11	220	356	2 574	120	30		.010 296	38.133 333	.480 480	1.048 320	11
12	286	425	4 004	143		35	.019 305	55.223 611	1.098 240	2.970 240	12
13	364	500	6 006	168	42		.034 320	77.371 429	2.333 760	7.637 760	13
14	455	581	8 736	195		48	.058 344	105.469 643	4.667 520	16.139 680	14
15	560	668	12 376	224	56		.095 472	140.462 540	8.868 288	40.310 460	15
16	680	761	17 136	255		63	.151 164	183.445 833	16.124 160	84.661 640	16
17	816	860	23 256	288	72		.232 560	235.466 667	28.217 280	169.303 650	17
18	969	965	31 008	323		80	.348 840	297.723 612	47.752 320	324.490 720	18
19	1 140	1 076	40 698	360	90		.511 632	371.466 667	78.450 240	599.074 560	19
20	1 330	1 193	52 668	399		99	.735 471	458.017 262	125.520 384	1 069.776 000	20
21	1 540	1 316	67 298	440	110		1.038 312	558.768 254	196.125 600	1 864.278 400	21
22	1 771	1 445	85 008	483		120	1.442 100	676.183 930	299.956 800	3 129.094 800	22
23	2 024	1 580	106 260	528	132		1.973 400	808.800 000	449.935 200	5 153.803 200	23
24	2 300	1 721	131 560	575		143	2.664 090	961.223 611	665.062 400	8 303.349 600	24
25	2 600	1 868	161 460	624	156		3.552 120	1 134.133 3	961.440 480	13 110.552 000	25
26	2 925	2 021	196 560	675		168	4.682 340	1 329.279 2	1 373.486 4	20 321.355 600	26
27	3 276	2 180	237 510	728	182		6.107 400	1 548.462 5	1 936.367 2	30 965.876 200	27
28	3 654	2 346	285 012	783		195	7.888 725	1 793.636 3	2 692.684 8	46 448.812 800	28
29	4 060	2 516	339 822	840	210		10.097 568	2 066.704 8	3 702.441 6	68 663.462 240	29
30	4 495	2 695	402 752	899		224	12.816 144	2 369.723 6	5 035.320 6	100 134.216 00	30
31	4 960	2 876	474 672	960	240		16.138 648	2 704.800 0	6 778.316 2	144 193.271 04	31
32	5 456	3 065	556 512	1 023		256	20.173 560	3 074.112 5	9 037.754 9	205 198.116 48	32
33	5 984	3 260	649 264	1 088	272		25.043 040	3 479.911 1	11 942.748	288 797.349 12	33
34	6 545	3 461	753 984	1 155		288	30.886 416	3 924.517 3	15 649.117	402 253.460 56	4
35	7 140	3 668	871 794	1 224	306		37.860 768	4 410.323 8	20 343.853	564 832.345 60	35
36	7 770	3 881	1 003 864	1 295		323	46.142 811	4 939.795 0	26 260.132	768 270.872 32	36
37	8 436	4 100	1 151 514	1 368	342		55.930 680	5 515.466 7	33 632.982	1 027 334.730	37
38	9 139	4 325	1 316 016	1 443		360	67.445 820	6 139.945 8	42 805.614	1 360 481.044	38
39	9 880	4 556	1 498 796	1 520	380		80.934 984	6 815.911 1	54 136.512	1 840 641.392	39
40	10 660	4 793	1 701 336	1 599		399	96.672 342	7 546.112 5	68 057.329	2 436 143.018	40

41	11 480	5 036	1 925 196	1 680	420		114.961 704	8 333.371 4	85 071.661	3 201 787.967	41
42	12 341	5 285	2 172 016	1 763		440	136.138 860	9 180.580 8	105 764.768	4 180 112.068	42
43	13 244	5 540	2 443 518	1 848	462		160.574 040	10 090.705	130 814.318	5 422 848.088	43
44	14 190	5 801	2 741 508	1 935		483	188.674 497	11 066.779	161 002.237	6 992 619.903	44
45	15 180	6 068	3 067 878	2 024	506		220.887 216	12 111.911	197 227.741	8 964 897.312	45
46	16 215	6 341	3 424 608	2 115		528	257.701 752	13 229.279	240 521.635	11 430 244.073	46
47	17 296	6 620	3 813 768	2 208	552		299.653 200	14 422.135	292 061.986	14 496 894.922	47
48	18 424	6 905	4 237 520	2 303		575	347.325 300	15 693.795	353 191.238	18 293 700.734	48
49	19 600	7 196	4 698 120	2 400	600		401.353 680	17 047.657	425 434.901	22 973 484.643	49
50	20 825	7 493	5 197 920	2 499		624	462.429 240	18 487.184	510 521.881	28 716 855.804	50
51	22 100	7 796	5 739 370	2 600	650		531.301 680	20 015.911	610 406.597	35 736 531.667	51
52	23 426	8 105	6 325 020	2 703		675	608.783 175	21 637.446	727 292.966	44 282 224.022	52
53	24 804	8 420	6 957 522	2 808	702		695.752 200	23 355.467	863 660.398	54 646 148.794	53
54	26 235	8 741	7 639 632	2 915		728	793.157 508	25 173.724	1 022 291.9	67 169 224.559	54
55	27 720	9 068	8 374 212	3 024	756		902.022 264	27 096.038	1 206 304.4	82 248 030.072	55
56	29 260	9 401	9 164 232	3 135		783	1 023.448 3	29 126.303	1 419 181.7	100 342 596.69	56
57	30 856	9 740	10 012 772	3 248	812		1 158.620 8	31 268.483	1 664 809.3	121 985 117.54	57
58	32 509	10 085	10 923 024	3 363		840	1 308.812 3	33 526.613	1 947 512.8	147 789 661.64	58
59	34 220	10 436	11 898 294	3 480	870		1 475.388 5	35 904.800	2 272 098.2	178 462 987.64	59
60	35 990	10 793	12 942 004	3 599		899	1 659.812 0	38 407.224	2 643 896.1	214 810 559.19	60
61	37 820	11 156	14 057 694	3 720	930		1 863.648 6	41 038.133	3 068 808.0	257 779 871.03	61
62	39 711	11 525	15 249 024	3 843		960	2 088.571 7	43 801.851	3 553 356.6	308 415 202.84	62
63	41 664	11 900	16 519 776	3 968	992		2 336.368 3	46 702.768	4 104 739.5	367 933 926.20	63
64	43 680	12 281	17 873 856	4 095		1 023	2 608.944 6	49 745.351	4 730 886.3	437 714 498.41	64
65	45 760	12 668	19 315 296	4 224	1 056		2 908.331 7	52 934.133	5 440 519.2	519 322 286.25	65
66	47 905	13 061	20 848 256	4 355		1 088	3 236.691 7	56 273.724	6 243 218.7	614 531 372.06	66
67	50 116	13 460	22 477 026	4 488	1 122		3 596.324 2	59 768.800	7 149 492.4	725 348 504.72	67
68	52 394	13 865	24 206 028	4 623		1 155	3 989.672 1	63 424.113	8 170 848.5	854 039 368.47	68
69	54 740	14 276	26 039 818	4 760	1 190		4 419.329 1	67 244.483	9 319 874.1	1 003 157 353.	69
70	57 155	14 693	27 983 088	4 899		1 224	4 886.045 8	71 234.603	10 610 318.	1 175 575 024.	70
71	59 640	15 116	30 040 668	5 040	1 260		5 398.737 2	75 400.038	12 057 180.	1 374 518 489.	71
72	62 196	15 545	32 217 528	5 183		1 295	5 954.489 6	79 745.224	13 676 801.	1 603 604 904.	72
73	64 824	15 980	34 518 780	5 328	1 332		6 558.568 2	84 275.467	15 486 966.	1 866 883 321.	73
74	67 525	16 421	36 949 680	5 475		1 368	7 214.425 0	88 995.946	17 507 005.	2 168 879 152.	74
75	70 300	16 868	39 515 630	5 624	1 406		7 925.706 4	93 911.911	19 757 905.	2 514 642 495.	75
76	73 150	17 321	42 222 180	5 775		1 443	8 696.261 1	99 028.684	22 262 429.	2 909 800 602.	76
77	76 076	17 780	45 075 030	5 928	1 482		9 530.149 2	104 351.657	25 045 232.	3 360 614 780.	77
78	79 079	18 245	48 080 032	6 083		1 520	10 431.650	109 886.295	28 133 000.	3 874 042 038.	78
79	82 160	18 716	51 243 192	6 240	1 560		11 405.270	115 638.133	31 564 582.	4 457 801 797.	79
80	85 320	19 193	54 570 672	6 399		1 599	12 455.756	121 612.779	35 341 131.	5 120 448 010.	80

N	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	N
61	88 560	19 676	58 068 792	6 560	1 640		13 588.097	127 815.911	39 526 265.	5 671 447 051.	61
62	91 881	20 166	61 744 032	6 723		1 680	14 807.542	134 253.279	44 146 218.	6 721 261 756.	62
63	95 284	20 660	65 603 034	6 888	1 722		16 129.603	140 930.705	49 240 013.	7 601 442 007.	63
64	98 770	21 161	69 652 604	7 056		1 763	17 530.068	147 854.081	54 849 635.	8 764 722 290.	64
65	102 340	21 668	73 899 714	7 224	1 806		19 045.012	155 029.371	61 020 218.	9 985 126 659.	65
66	105 995	22 181	78 351 504	7 395		1 848	20 670.806	162 462.612	67 800 243.	11 358 081 575.	66
67	109 736	22 700	83 015 284	7 568	1 892		22 414.127	170 159.911	75 241 733.	12 900 537 098.	67
68	113 564	23 225	87 898 536	7 743		1 935	24 281.971	178 127.446	83 400 475.	14 631 096 952.	68
69	117 480	23 756	93 008 916	7 920	1 980		26 281.662	186 371.467	92 336 240.	16 570 157 994.	69
70	121 485	24 293	98 354 256	8 099		2 024	28 420.867	194 898.295	102 113 018.	18 740 059 636.	70
71	125 580	24 836	103 942 566	8 280	2 070		30 707.604	203 714.324	112 799 265.	21 165 243 824.	71
72	129 766	25 385	109 782 036	8 463		2 115	33 150.254	212 826.017	124 468 154.	23 872 426 174.	72
73	134 044	25 940	115 881 038	8 648	2 162		35 757.577	222 239.911	137 197 852.	26 890 778 908.	73
74	138 415	26 501	122 248 128	8 835		2 208	38 538.722	231 962.612	151 071 792.	30 252 126 272.	74
75	142 880	27 068	128 892 048	9 024	2 256		41 503.239	242 000.800	166 178 971.	33 991 153 114.	75
96	147 440	27 641	135 821 728	9 216		2 303	44 661.095	252 361.224	182 614 254.	38 145 627 384.	96
97	152 096	28 220	143 046 286	9 408	2 352		48 022.682	263 050.705	200 478 691.	42 756 637 288.	97
98	156 849	28 805	150 575 040	9 603		2 400	51 598.840	274 076.136	219 879 855.	47 868 843 920.	98
99	161 700	29 396	158 417 490	9 800	2 450		55 400.859	285 444.483	240 932 162.	53 530 750 190.	99
100	166 650	29 993	166 583 340	9 999		2 499	59 440.505	297 162.779	263 757 336.	59 794 986 914.	100

NOTE.—Each column of Table III except K_9 was set up by summation and checked at every tenth item by independent calculation. K_9 was calculated from K_7 and K_{10} separately thereby checking all three columns. The values of K_7, K_8, K_9 and K_{10} are given to at least eight significant figures which is adequate for most statistical work. If a greater number of places are desired they can be secured from K_3 by rather obvious multiplications.

The K-values represent the following functions of N:

$$K_1 = \frac{N(N^2-1)}{6} \qquad K_7 = \frac{(N^2-9)}{28{,}000{,}000} K_3$$

$$K_2 = 3N^2-7 \qquad K_8 = \frac{15N^4-230N^2+407}{5{,}040}$$

$$K_3 = \frac{N(N^2-1)(N^2-4)}{60} \qquad K_9 = \frac{(N^2-9)(N^2-16)}{63{,}000{,}000} K_3$$

$$K_4 = N^2-1$$

$$K_5 = \tfrac{1}{4}(N^2-1) \ (N \text{ odd only}) \qquad K_{10} = \frac{(N^2-9)(N^2-16)(N^2-25)}{2{,}772{,}000{,}000} K_3$$

$$K_6 = \tfrac{1}{4}(N^2-4) \ (N \text{ even only})$$

NOTES

THE TEST OF SIGNIFICANCE FOR THE CORRELATION COEFFICIENT: SOME FURTHER RESULTS

By Egon S. Pearson, *University of London*

In an earlier paper I have discussed the distribution of r in samples from non-normal populations in which $\rho = 0$.[1] For the cases considered there, the population distributions for both x and y variables were taken to be the same, but it was suggested that it would be of interest to examine the position when x was drawn from one form of population and y from another. Further results of this character have now been obtained.

They consist of 3 series, drawn as follows,[2]

Series (a)	x	variable	from	population	(1) $(\beta_1 = 0.00, \beta_2 = 2.50)$
	y	"	"	"	(2) $(\beta_1 = 0.00, \beta_2 = 7.05)$
Series (b)	x	"	"	"	(1)
	y	"	"	"	(4) $(\beta_1 = 0.99, \beta_2 = 3.83)$
Series (c)	x	"	"	"	(2)
	y	"	"	"	(4)

For each series there are 500 samples of 10 and 500 samples of 20. The experimental and normal-theory values of the frequency constants are compared in Table I. Since in each series at least one of the popu-

TABLE I

FREQUENCY CONSTANTS IN EXPERIMENTAL DISTRIBUTIONS OF r

Populations sampled	Samples of 10				Samples of 20			
	σ_r	B_1	$\sqrt{B_1}$	B_2	σ_r	B_1	$\sqrt{B_1}$	B_2
(1) and (2)	.3299	.014	−.117	2.465	.2276	.002	+.050	2.630
(1) and (4)	.3161	.000	−.009	2.356	.2269	.002	−.040	2.665
(2) and (4)	.3235	.001	−.024	2.529	.2260	.001	−.029	2.739
Normal theory values	.3333	0	0	2.455	.2294	0	0	2.714
Standard errors*	.0090		.074	.104	.0067		.088	.144

* Standard errors are those appropriate for 500 samples.

lation distributions is symmetrical, the sampling distribution of r must be symmetrical, and any difference between B_1 and zero can only be due to sampling fluctuations. Observed values of B_1 and $\sqrt{B_1}$ have, however, been tabled as in the previous work. The agreement of σ_r and B_2 with the normal theory values is very close, except for samples

[1] This Journal, June 1931, pp. 128–134.

[2] The population numbering is as in the earlier paper.

of 10, series (b); here the observed variation as measured by σ_r is too small by an amount approaching twice the standard error. This difference can also be traced in Table II.

TABLE II

EXPERIMENTAL SAMPLING DISTRIBUTIONS OF r WHEN $\rho=0$ (SAMPLES OF 10)

r	"Normal theory" frequencies	Populations sampled		
		(1) and (2)	(1) and (4)	(2) and (4)
00–05	54.6	57	47	59
05	53.7	55	58	51
10	52.1	54	45	54
15	49.8	57	57	47
20	46.8	38	58	59
25	43.2	37	47	34
30	39.1	44	44	51
35	34.7	36	29	34
40	30.1	21	35	26
45	25.3	24	27	19
50	20.8	28	14	20
55	16.5	20	17	18
60	12.3	11	10	8
65	8.9	11	5	7
70	5.8	3	4	8
75–80	3.6	1	2	3
Greater than 80	2.7	3	1	2
Totals	500.0	500	500	500
Goodness of fit: χ^2		13.30	15.55	14.80
Goodness of fit: n'		16	16	16
Goodness of fit: $P(\chi^2)$		0.58	0.41	0.47

TABLE III

EXPERIMENTAL SAMPLING DISTRIBUTIONS OF r WHEN $\rho=0$ (SAMPLES OF 20)

r	"Normal theory" frequencies	Populations sampled		
		(1) and (2)	(1) and (4)	(2) and (4)
00–03	50.0	47	52	43
03	49.2	47	49	51
06	47.9	60	46	50
09	45.7	42	41	38
12	43.3	37	54	57
15	40.1	38	32	34
18	36.7	44	34	42
21	33.0	29	32	43
24	29.3	29	34	25
27	25.4	29	26	23
30	21.7	21	28	21
33	18.2	19	20	15
36	14.9	15	15	20
39	12.0	10	10	11
42	9.4	11	6	7
45	7.1	10	5	6
48	5.3	4	5	4
51	3.8	2	5	1
54	2.6	4	..	3
57–60	1.8	1	4	2
Greater than 60	2.6	1	2	4
Totals	500.0	500	500	500
Goodness of fit: χ^2		10.60	10.99	17.35
Goodness of fit: n'		19	19	19
Goodness of fit: $P(\chi^2)$		0.91	0.89	0.50

The "doubled over" experimental distributions are compared with corresponding normal-theory frequencies in Tables II and III, and the result of applying the (P, χ^2) test for goodness of fit is shown. The agreement is remarkably satisfactory.

The adequacy of the fit for practical purposes may be illustrated as follows:

For $n = 10$, normal-theory predicts that in 500 random samples from uncorrelated material we should expect to find 21.0 with $|r| \geq .65$. We find,

Series	(a)	(b)	(c)
Cases	18	12	20

Further, for $n = 20$ we should expect in 500 samples, 23.2 with $|r| \geq .45$. We find,

Series	(a)	(b)	(c)
Cases	22	21	20

It will be noticed that in all cases there are *less* observed values beyond the limits, than theory predicts. The differences are, however, very small except in the one case $n = 10$, series (b), for which the populations are, (1) platykurtic and (4) very skew. It is most probable that this last disagreement is not altogether a sampling fluctuation, but it will be seen that it is not repeated for $n = 20$.

Taken with other results,[1] these figures again emphasize the insensitiveness of the sampling distribution of r to changes in population form.

[1] For recent experiments in cases where ρ is not zero see, Chesire, Oldis and Pearson, this JOURNAL, June 1932, pp. 121–128; Paul Rider, a paper shortly to appear in *Biometrika*.

NOTE ON AGE AT TIME OF MARRIAGE IN TWO MEXICAN LOCALITIES OF DIVERGENT TYPES

By Paul S. Taylor, *University of California*

Studies of age at time of marriage bear specifically upon rate of population growth and reveal, as well, customs of general social importance. This note presents the results of recent researches in ecclesiastical archives of two localities in Mexico, a country in which reliable population data have been distressingly meagre.

Arandas is a *municipio* (county) in Los Altos of Jalisco, central Mexico, a region inhabited by small peasant proprietors, probably about 85 per cent of whose collective ancestry is Spanish. Its people are strongly anti-*agrarista* and ardently Catholic; they furnished the bulwark of the powerful Cristero revolution against the Mexican government from 1926 to 1929. The region has been, and continues to be, a source of rapid population increase. According to the census of 1930, its population was 27,624, of whom 7,574 lived in the town of Arandas, the only really important population center in the municipio.

San José Tateposco, Jalisco, is a small *pueblo* (village) a few miles distant from Guadalajara. Its inhabitants, who numbered 441 in 1930, are collectively about 85 per cent of Indian stock. Their traditional and contemporary occupations have been the making of pottery, and agriculture; the agricultural activities are limited to cultivation of very small plots, and day labor on the adjoining hacienda. Catholicism is universally accepted, but in recent years the formation of a *comunidád agrária* by many of its inhabitants who have obtained lands from the hacienda under the agrarian law, has thrown their allegiance to the side of the government rather than to the Cristeros.

Railways and good highways penetrate neither Tateposco nor Arandas; both are physically and socially isolated. Marriages of the Tateposqueños have been, and continue to be, almost universally with persons of the same village. The comparatively few marriages in Arandas involving one party from outside the municipio have practically always been contracted with persons from other parts of Los Altos, a region which is homogeneous. In Arandas there are persons of small town and rural middle-class, a type which is absent from Tateposco.

Data on age at time of marriage which practically bracket a century are presented in the accompanying table. The actual selection of the samples in each of the localities was influenced largely by the availabil-

TABLE I

COMPARISON OF CHANGES DURING THE PAST CENTURY IN AGE AT TIME OF MARRIAGE IN ARANDAS AND IN SAN JOSÉ TATEPOSCO, JALISCO, MEXICO, AS SHOWN BY SAMPLE GROUPS OF 100 COUPLES EACH*

Age	Number								Cumulative Total							
	Men				Women				Men				Women			
	Arandas		Tateposco		Arandas		Tateposco		Arandas		Tateposco		Arandas		Tateposco	
	1825–6	1930	1831–65	1902–32	1825–6	1930	1831–65	1902–32	1825–6	1930	1831–65	1902–32	1825–6	1930	1831–65	1902–32
12	..	..	..	..	1	..	2	..	..	..	..	..	1	..	2	..
13	..	..	..	..	..	..	1	..	..	..	..	..	1	..	3	..
14	..	..	..	..	4	1	12	..	..	..	..	..	5	1	15	..
15	2	..	3	..	21	10	30	19	2	..	3	..	26	11	45	19
16	2	..	7	..	24	7	22	23	4	..	10	..	50	18	67	42
17	3	1	7	1	9	17	13	10	7	1	17	1	59	35	80	52
18	13	2	25	8	14	16	13	26	20	3	42	9	73	51	93	78
19	11	6	9	11	12	10	3	9	31	9	51	20	85	61	96	87
20	18	7	24	29	5	5	1	4	49	16	75	49	90	66	97	91
21	6	9	5	10	2	5	1	1	55	25	80	59	92	71	98	92
22	12	16	2	21	5	14	..	4	67	41	82	80	97	85	98	96
23	7	12	2	6	..	2	..	2	74	53	84	86	97	87	98	98
24	2	11	4	6	..	2	..	..	76	64	88	92	97	89	98	98
25	10	9	8	4	1	4	1	1	86	73	96	96	98	93	99	99
26	3	6	1	..	..	3	..	..	89	79	97	96	98	96	99	99
27	4	4	1	1	..	1	1	..	93	83	98	97	98	97	100	99
28	..	4	..	2	..	..	..	1	93	87	98	99	98	97	100	100
29	..	2	..	..	..	1	..	..	93	89	98	99	98	98	100	100
30	2	4	1	1	1	2	..	..	95	93	99	100	99	100	100	100
Above 30	5†	7‡	1¶	..	1§	..	..	..	100†	100‡	100¶	100	100§	100	100	100

* Data from *Registro de matrimonio*, Arandas, and Tonalá, respectively. See text for description of method of obtaining sample groups.
† One person each, aged 35, 41, and 44; two persons aged 32.
‡ One person each, aged 32, 33, and 34; two persons each, aged 35 and 39.
¶ Aged 33.
§ Aged 40.

ity of data in the respective archives. Though not obtained in identical manner in the two localities, they are nevertheless believed to be comparable for the purposes of this note. The Arandas samples include the first one hundred first-marriages (i.e., excluding widowers and widows) during the years indicated in the table. The Tateposco samples represent all first-marriages from January 7, 1831, to May 22, 1865, and from May 15, 1902, to July 13, 1932, respectively. The smallness of the Tateposco population practically compelled this method; observation of the records year by year while compiling the table leads to the conclusion that no important distortion, or concealment of trends, has resulted. Ecclesiastical registration has been really effective in both localities throughout the period under review.

It will be noted upon examination of the data in the table that the age of marriage of both men and women is markedly earlier in Tateposco than in Arandas, both historically and contemporaneously. Thus in the first period, 55 per cent of the Arandas men and 80 per cent of the Tateposco men married when under 22 years of age. In the contemporary period, the comparable figures were 25 per cent and 59 per cent, respectively. Among the women, 85 per cent of those from Arandas and 96 per cent of those from Tateposco married when under 20 years of age, during the first period. In the contemporary period, the comparable figures were 61 per cent and 87 per cent, respectively.

So far as age at time of marriage is concerned, in both these rural, isolated, separated, Catholic communities—the one "Spanish" and peasant proprietor, the other "Indian" and potter and agricultural laborer—the tendency has been notably toward the operation of this preventive Malthusian check to population increase, but the tendency has been more marked in the former than in the latter. In Arandas the advance in age was more marked among men than among women. Thus, for example, the percentage of Arandas men who married when under 21 years of age fell from 49 to 16, and the percentage of Tateposco men fell from 75 to 49, during the period under review. The percentage of Arandas women who married when under 19 years of age fell from 73 to 51, and the percentage of Tateposco women dropped from 93 to 78. Other comparisons may be made by consulting the table.

The differences and changes in age at time of marriage, as shown by median and mean ages, are as in Table II.

Thus the mean age at time of marriage of Arandas men advanced 2.1 years (median 2.6) while the mean age of Arandas women advanced 1.4 years (median 1.2). The mean age of Tateposco men advanced

1.4 years (median 1.2) and the mean age of women advanced 1.4 years (median 1.6).

TABLE II

Age	Men				Women			
	Arandas		Tateposco		Arandas		Tateposco	
	1825–6	1930	1831–65	1902–32	1825–6	1930	1831–65	1902–32
Median	21.2	23.8	19.9	21.1	17.0	18.9	16.2	17.8
Mean	22.0	24.1	19.8	21.2	17.5	19.4	16.1	17.5

ERRATA

Two corrections should be made in the article by Edward V. Huntington, "An Improved Equal-Frequency Map of the Normal Correlation Surface, Using Circles Instead of Ellipses," in the September, 1932, issue of this JOURNAL:

Page 255, last line, for ρ read p:

Page 255, third line from bottom, for s read e.

THE OUTLOOK FOR THE PRICE LEVEL

A dinner meeting of the American Statistical Association was held on Thursday evening, September 29, 1932, at the Hotel Empire, Broadway and 63rd Street, New York City. One hundred forty-seven persons were present. The President of the Association, Irving Fisher, was in the chair. The general topic for discussion was, *The Outlook for the Price Level.*

The first speaker of the evening was Lionel D. Edie, President of the Capital Research Company. His subject was "The Effect of the Federal Reserve Policy." He began by stating that the event of greatest importance to the people of the United States in 1932 was the halting of the deflation movement which had continued since 1929. He expressed the opinion that it was the passage of the Goldsborough Bill through the House and the threat of enactment of the Patman Bill which precipitated action by the Federal Reserve authorities.

The main force which stopped the downward trend of wholesale commodity prices was the purchase of large quantities of government bonds by the Federal Reserve Banks. Since prices continued to decline for some time after the policy of rapid purchasing was begun, many believed that the open market activity of the Federal Reserve system was not responsible for checking the downward movement. As a matter of fact, however, a lag was to be expected, for, in previous instances a considerable period had elapsed between the time of Federal Reserve action and the resultant effect upon the price level.

The recent upturn of prices has been aided by the natural speculative rebound following a period of abnormally low prices in basic commodities. This rebound is partly to be explained by short covering and partly by the fact that, as soon as buyers feel that prices are not going lower, they are ready to enter the market. As yet, the large surpluses of raw materials accumulating during the period of depression have not been dissipated, but they appear to have reached a point where they are not increasing further and, in respect to certain commodities, they have shown declines.

Since there has, as yet, been no marked increase in the supply either of currency or of deposits subject to check there is, at present, little reason to expect any marked rise in commodity prices. If, however, the present policy of the Federal Reserve Banks is maintained, it is unlikely that the price decline will be resumed.

It is hard to over-estimate the importance of the demonstration which we have had of the ability of central banks to arrest violent price movements. It will be

a great misfortune if, in the future, this lesson is overlooked, forgotten, or ignored.

At present, we are confronted by two dangers:

1. The Federal Reserve Banks may yield to the pressure of certain influential groups and prematurely begin selling the government bonds which they now hold in their portfolios. Should they do this soon, it is almost certain that incipient recovery would be either seriously retarded or entirely overcome.

2. The reserves of member banks may be increased further by gold inflow and by return flow of currency. If, as time passes, optimism returns and loans multiply unduly at the member banks, the Federal Reserve Banks may hesitate too long before attempting to put on the brakes.

Dr. Edie closed by stating that he considered it probable that, during the next six months, the price level will not increase by a percentage greater than the increase in the volume of business activity.

At the close of Dr. Edie's paper, the Chairman remarked that reports from Sweden indicate that, for more than a year now, prices have been almost completely stabilized through central bank action. Sweden, being off the gold standard and employing a managed currency, can readily stabilize prices.

The second speaker of the evening was Professor F. A. Pearson of Cornell University who discussed "The Relation of Gold to Prices." He illustrated his remarks by aid of a considerable number of charts. Professor Pearson pointed out that the world physical volume of production has, for a long time, tended to increase at a compound rate of about 3.15 per cent a year, or 1.91 per cent per year, when reduced to a per capita basis. During, and after, the World War, however, these rates fell off sharply, and not until 1927 did world production get back to its normal trend. While physical production of other commodities tends to move along a straight line on a ratio chart, the production of gold proceeds in huge waves. One such wave reached its peak in the early 50's; the next wave crest was just before the World War, and the third high wave has very recently been starting its development. Between 1850 and 1914, the index of wholesale prices in England paralleled very closely the ratio of world gold stocks to world physical production of commodities. Between the beginning of the World War and 1929, the wholesale price level, both in England and the United States, was far above the index representing this ratio. At present, however, it has fallen below this index. It appears, therefore, that while, in the long run, the price level is dependent almost entirely upon the ratio of world gold supply to world production, there are many short-time discrepancies due to business cycles and other causes.

Fifty-six per cent of the world's gold production during the last eighty years has been added to monetary stocks. During a period when gold production is low, the percentage added to monetary stocks declines. This percentage is also affected by business cycles. There seems to be no tendency for a permanent change in the long-time trend.

It is necessary that monetary stocks increase 3.15 per cent per year in order to maintain stable commodity prices. To provide for this increase and the normal amount used in the arts, the annual gold production must be 5.6 per cent of monetary stocks. Whenever gold production is below this rate, the trend of

prices tends to be downward. High or low production changes but slightly the stocks of gold on hand. Therefore, price changes lag after gold production. For the United States, the best fit is found with a lag of about 13 years. The amount of this lag is accidental, for it depends upon the rate of gold production. If a gold supply equal to existing monetary stocks were mined in a single year and added to the stocks, prices would probably double in the following year.

Available statistics indicate that, in the United States, if stable prices are to be maintained, credit must increase materially faster than production and the gold supply.

Professor Pearson concluded by showing an interesting comparison between a demand curve for gold and a demand curve for corn. His figures indicated that these two curves are very similar in shape. He stated, also, that the demand curves for wheat, oats, hay and cattle, closely resemble those for gold and corn. A study of these demand curves shows that, when the supply of gold is 20 per cent below normal, the value of gold is 23 per cent above normal. When the supply of gold is 20 per cent above normal, its purchasing power is 15 per cent below normal.

The third speaker of the evening was Professor George F. Warren, also of the Department of Agricultural Economics of Cornell University. He discussed the future of the general price level. Professor Warren began by reading from a bulletin published in 1922 and in which he discussed the probable future of commodity prices. At that time, he pointed out that, when European nations decided to return to gold bases, they would draw gold to Europe and prices would tend to fall toward the pre-war level. He also showed that the lowered value of gold, brought about by the War, would tend to diminish the volume of gold production. As everyone knows, both of these forecasts have been amply verified by the facts.

A question which has bothered economists is why prices, measured in gold, rose so greatly between 1914 and 1920. In Dr. Warren's opinion, part of this rise was due to reduced use of gold by many countries and part was caused by the fact that so much of the trade of the world was being conducted by governments and, hence, there was little demand for money, and especially for gold, in carrying on this trade. Prices fell in the period 1920–1921 when business returned to private hands.

The recent downward tendency in prices, as measured in gold, has been brought about by the great scramble for gold reserves caused by the European nations returning to the gold standard. Just now, many countries have gone off the gold standard again, but most of them are still contemplating returning to it and hence are anxious to continue accumulating gold.

At present, prices are somewhat below the trend indicated by the relationship of gold to normal production. The trend indicates that the price level should return to approximately its pre-war altitude. This does not mean a large advance for most prices. However, the prices of many farm products have recently averaged only about half of what they were before the World War. There is, then, plenty of room for a sharp improvement in these prices. The gold supply of the world today is sufficient to maintain prices somewhat higher than those

predominating before the World War, but this condition cannot be expected to continue if production and business activity return to normal. The present volume of gold production is only about three-quarters of the normal requirements. With the present gold production, and all the world on a gold basis, we should expect prices to decline about 1 per cent per annum.

One feature of the present situation is decidedly unfavorable. We are attempting to adjust ourselves to a lowered price level. This means that we are under the necessity of liquidating debts incurred at a higher price level. The chances are that the burden of these debts will tend, for some time to come, to prevent the development of real prosperity. We are, therefore, at present, victims of the radical policy of attempting to liquidate debts incurred in the past. The more conservative policy would have been to adjust our price level upward to the plane which it occupied when the debts were incurred. This would have been a more conservative procedure, even if it had necessitated changing the weight of gold in the dollar.

The fourth regular speaker was Mr. Frederick R. Ottman of the Economics Department, New York University, who spoke on the subject, "Probable Changes in the Velocity of Circulation." He presented charts showing the relationship between the velocity of circulation of bank deposits, the volume of trade, and the price level. He pointed out that the velocity of circulation of bank deposits in New York City fluctuates through a wider amplitude than does the velocity of deposits in banks outside of the metropolis. A study of the figures which are now available for something like a decade, does not indicate that there is any close correlation between the velocity of circulation of bank deposits and the general price level. In a number of instances, the indications are that price movements have anticipated changes in velocity. Under these circumstances, it does not seem probable that velocity can correctly be assumed to be a causal factor as regards price changes.

The fact, however, should not be overlooked that, during the period when security prices were rising very rapidly, there was no corresponding increase in the volume of money or bank deposits, subject to check. During this period, the equation of exchange was balanced primarily by an increase in the velocity of circulation. Had such an increase in velocity not been possible, it might well have been true that security prices could not have risen as they did.

All the evidence indicates that changes in velocity are closely coupled with changes in the volume of trade. At present, the velocity of circulation of bank deposits is far below normal and so is the volume of trade. Both may be expected to increase together at about the same rate. There is, therefore, no reason for believing that this anticipated increase in velocity will tend to cause a rise in the price level.

The discussion from the floor was opened by Emile Despres of the Federal Reserve Bank in New York. He raised several questions concerning the arguments advanced by Professors Warren and Pearson. The first of these questions was whether the price level was not governed primarily by the extent of the reserves found in the central banks rather than by the total stock of gold in the world. He pointed out that the stocks of gold in the world's central banks and

treasuries have apparently increased sufficiently to keep prices at a level 50 per cent above pre-war. Mr. Despres could see no reason why the ratio of credit to gold might not be expanded, thus lifting the price level still further without any increase in the supply of gold. He also felt that Professor Warren erred both in taking the prices of commodities at wholesale as a criterion of the general price level, and in using production of basic materials as a criterion of the volume of trade. He pointed out that production of such commodities has not been increasing as fast as the volume of trade.

Professor Warren replied to Mr. Despres by stating that what he was attempting to measure was the relationship between the gold supply and the prices of commodities at wholesale. He agreed fully with Mr. Despres that there is, at present, more trade per unit of basic commodities produced than was formerly true and he stated that it was because of this fact that credit must increase faster than the volume of physical production of basic commodities, if a steady price level is to be maintained.

Professor Warren stated that Mr. Despres' belief that it was possible to expand materially the ratio of credit (including paper currency) to gold is not borne out by the experience of the past. In several instances, such an expansion has taken place, but each time a crash has resulted. It appears, then, that the relationship between the volume of credit plus currency and the gold supply does not have a sharply upward trend but rather one which is very slowly upward, and that departure from this trend is fraught with no little danger to business. Dr. Warren also held that Mr. Despres overlooked the fact that gold is a commodity and that its value is governed by the same law governing the value of other commodities.

By superimposing upon a gold basis a large volume of credit, prices may be temporarily forced upward but, when prices rise, a business reaction is probable. The attempt, therefore, to use expansion of credit to maintain a higher level of prices than is warranted by the stock of gold is doomed to failure. If it were possible to do this, gold production would be discouraged.

Dr. Warren pointed out that many economists overlook the fact that the world is still on its way toward a gold basis. India is approaching a full gold standard and China and South America are looking in that direction. We have, therefore, in prospect an increasing demand upon the gold stocks of the world.

Dr. W. W. Cumberland asked two questions of Dr. Edie:

1. How far could the Federal Reserve Banks proceed in their program of buying government securities without destroying confidence and reaching the limits of their reserves? Might it not well have happened that this point would have been reached before they succeeded in stopping the price level decline? If so, what could they have done about it?

2. If, in the future, prices should begin to rise rapidly, and, in an endeavor to stop such a rise, the Federal Reserve Banks should sell out all their holdings of government securities, but prices should still move upward, what could the Federal Reserve Banks then do?

Dr. Edie made no definite response to the first question but, in answer to the second, said that the Federal Reserve Banks could put pressure upon the

member banks to hold down their volumes of loans and, in this manner, tend to head off a period of inflation. He admitted, however, that it was possible that the Federal Reserve Banks might lose control of the situation, despite their best endeavors.

WILLFORD I. KING, *Secretary*

PROGRESS OF WORK IN THE CENSUS BUREAU

The three-year period allowed by law for the completion of the reports of the Fifteenth Census ends on December 31; and the temporary force, numbering at this date (November 1) about 630, as compared with a maximum of 6,022 reached on November 1, 1930, will have to be discharged before the appropriation for that census becomes exhausted. But if, happily, there should be any unexpended balance on December 31, a clause in the appropriation Act makes it legitimate to use it for Fifteenth Census work continued beyond that date; and there is a hope that under this provision of the law some small sum may be available for continuing work on census studies or monographs. All the copy for the thirty-two main volumes of Census reports has already been forwarded to the printer; nine volumes have been printed; and all or nearly all the remaining volumes should be printed by the end of the year.

On January 1, then, the Bureau will go back to the regular basis of organization with a permanent force of about 730 employees; and its work for the following six months must be carried on under its appropriation for the fiscal year 1932–1933, which, by the way, is about 27 per cent below the amount asked for in the estimates. This reduction was demanded by the program of government economy, being a part of the general reduction of government expenditures made with a view to balancing the budget. While this limitation in the funds available for the Bureau will involve some curtailments in the work as originally planned, it will not mean the abandonment of any field of statistical inquiry regularly covered by the Bureau in the year following the completion of the decennial census. The Bureau will get out its regular annual reports on deaths and births, on marriages and divorces, and on financial statistics of states and cities; and will organize and carry on the other periodical inquiries which under the ten-year program of census work are due at this time. These include the decennial inquiry on wealth, public debt, and taxation, and that on institutional classes, the quinquennial inquiry on electrical industries, and the biennial census of manufactures.

Biennial Census of Manufactures.—Work on the biennial census of manufactures is practically continuous, as the work on one census begins before that on the preceding census is ended. The census of manufactures covering the year 1929 was taken and published as a part of the Fifteenth Census of the United States, thus superseding or replacing the biennial census that was due for that year. The results will be published in three volumes of Fifteenth Census reports. In one of these the statistics are assembled by states, in another by industries, and in a third—the general report—by subjects. The collection of data for the biennial census covering the year 1931 has been finished, and the

publication of the preliminary results by industries, in the form of press releases, is nearing completion.

Report on National Wealth, Public Debt, and Taxation.—Under the law establishing the permanent census, enacted in 1902, the Director of the Census is authorized to collect decennially statistics relating to "public indebtedness, valuation, taxation, and expenditures"; and this compilation has been regularly made for the second year following the decennial census year, beginning with the year 1902.

The statistics for the present inquiry will be collected and presented under three main divisions: (1) Public receipts and payments; (2) public indebtedness; and (3) assessed valuations and tax levies.

For 1922 no statistics in regard to payments were secured other than those regularly obtained for the annual reports on financial statistics of states and of cities of over 30,000; and for 1912 the statistics of payments as compiled in the decennial inquiry did not go beyond those for states, counties, and cities of over 2,500 population. This time it is proposed to obtain statistics in more or less detail covering payments for all states, cities, counties, and other civil divisions.

The payments will be classified with respect to purpose under the following heads: (1) General government; (2) protection to person and property; (3) health and sanitation; (4) highways; (5) charities, hospitals, and corrections; (6) schools; (7) libraries; (8) recreation; (9) miscellaneous; (10) public service enterprises; (11) interest; (12) payments on account of debt obligations.

This classification will be shown in full for all state and county governments and all cities so far as possible; but for the smaller cities and minor civil divisions it will not be practicable to obtain all this detail, and a condensed classification will be used distinguishing simply expenditures for (1) all general departments; (2) public service enterprises; (3) interest; and (4) debt obligations. Outlay payments for permanent improvements will be separately shown.

There will be an equally detailed classification of receipts, distinguishing the general property taxes; special taxes, subdivided as (a) inheritance, (b) income, and (c) all other; poll taxes; licenses and permits; special assessments; and certain other specific sources of revenue.

To a large extent it will be possible to secure the required data from reports on file at the state capitals. There are in fact 16 states which require all minor civil divisions to make reports to some state department. The list comprises Arkansas, California, Indiana, Iowa, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, Washington, West Virginia, and Wisconsin. These states have adopted in the main the classification of receipts and payments applied by the Bureau of the Census in its annual reports on financial statistics of states and cities, and therefore the detail that is desired will be readily available. There are 16 other states which have data at the state capitals for county governments and for some other civil divisions. The remaining 16 states have practically nothing available at the state capitals except statistics on assessed valuations and tax levies and on schools.

The data not available at the state capitals will be secured by a mail canvass. Local agents at the state capitals are now compiling all the data there available;

and the mail canvass is in progress and will be completed during this calendar year. This method of collection will represent a material saving in expense as compared with the method followed ten years ago, when there were only a few states for which any data other than those relating to the state governments were available at state capitals, and in order to obtain the statistics agents of the Bureau visited practically every county in the United States.

Included with this inquiry, although not organically connected with it, is the census estimate of National wealth, which has been made in connection with or following each decennial census beginning with that of 1850. From 1850 to 1870, inclusive, the figures covered simply the true value of taxable property, both real and personal, as estimated upon the basis of the assessed valuation and reported for counties by the assistant marshals, who were the census enumerators of those days; and the figures as published by states were probably simply a summation of these reports for the counties. But in the more recent censuses the estimates have been made centrally at the Bureau in Washington; and while the estimate of the value of real property is in large part based upon the assessed valuation of real estate as reported in the census of taxation, other data derived from the censuses of agriculture, manufactures, and electrical industries, and from other sources are used in estimating other forms of property. The estimate of wealth must wait upon the results of the census of taxation for some of the basic data, and no definite plans regarding it have been formulated as yet.

Census of Institutional Classes.—This is another inquiry provided for in the permanent Census Act of 1902, which authorized the Director to collect decennially statistics relating to "the defective, dependent, and delinquent classes," with the proviso that these statistics should be restricted to institutions containing such classes, which proviso was not, however, retained in a later revision of that section of the law. The census, however, continues to be limited to institutional classes. For 1922 it covered sentenced prisoners in prisons, reformatories, jails, and other penal institutions; patients in hospitals for mental disease; inmates of institutions for the feeble-minded and epileptic; paupers in almshouses; and children under institutional care. It included also statistics regarding hospitals and dispensaries. As the plans for the next census are still more or less in the formative stage, a report on this subject may best be presented in a later issue of this JOURNAL.

J. A. H.

MISCELLANEOUS NOTES

Committee on Governmental Labor Statistics.—Since its last report, the Committee's study of Statistical Procedure in Public Employment Offices has been completed for publication by the Russell Sage Foundation. It is published for the Committee as a companion volume to *Employment Statistics for the United States*, which contains the Committee's recommendations for governmental statistics of employment and unemployment. The forthcoming study is closely related in that it sets up a plan for making the administrative material of public employment offices available as a measure of demand and supply in the labor market. It describes in detail the sta-

tistical procedures of public employment offices in Great Britain, Germany, France, Switzerland, Sweden, Canada and the United States, based on field work in those countries, and suggests standard procedure for public employment offices in the United States. Experimentation with this procedure is already under way in the public employment office demonstration centers at Rochester, Philadelphia and Minneapolis, and conferences with representatives of the centers have been held concerning installation of the procedure and possible short cuts in its use.

In general it can be said that the plan is meeting the test of actual use quite well. While a number of suggestions for reducing the clerical work it involves have been received, all of these would make it impossible to identify the individual transactions in the statistical totals, one of the principal features of the suggested procedure. Employment office executives present at the conferences have insisted that this identification principle should be retained so that fraudulent returns of placements may not be made by local offices and that inspection of the offices may be more effective. It has also been revealed that the procedure does not involve more clerical work than some of the reporting systems now in use.

The recommendations of the study were presented to the International Association of Public Employment Services at its recent annual meeting in Washington. If, as may be anticipated, legislation both in Congress and in the states results in more adequate development of a national public employment service in the United States, this study will be ready as a handbook of practical suggestions and a basis for uniformity in statistical and administrative measurements.

The Cleveland Chapter.—The Business Statistical Group of the Cleveland Chapter held its first meeting of the season on Monday, September 26.

Mr. D. A. Hill of the Ohio Public Service Corporation, Vice-President of the local Chapter, will act as Chairman for the coming year. Mr. E. A. Stephen, Secretary of the Chapter, will continue as Secretary for the Business Group.

The meeting was devoted to a forecast of the Annalist index of business activity for the coming year.

The Chapter regretted to learn of the death of one of its most active members, Mr. R. H. Hammond of the White Motor Company.

The Los Angeles Chapter.—A meeting of the Los Angeles Chapter was held on April 27, the speaker of the evening being Mr. Eugene Rittenhouse, a stock market analyst of some twenty years' experience. Mr. Rittenhouse spoke on the probable trend of the stock market, basing his prognostications on the various movements of the Dow-Jones Index of industrial stocks. It was his contention that the stock market acts in long-time swings of accumulation and distribution lasting about thirty to forty years in length. He maintains that the panics of 1907, 1915 and 1921 were merely minor movements of the accumulation process and that the distribution of stocks to the general public did not begin until about 1928, ending, of course, in the debacle of 1929. The movement of the stock market since that time he described as being the preliminary movement of another period of accumulation which, it is expected, will cover the coming generation. From his calculations he estimated that the Dow-Jones Index would reach a level of approximately 37.5 by May, 1932, the lowest point for many years to come. It was his further contention that late in June or early in July an inflationary movement of considerable magnitude would come with the result the Dow-Jones Index would reach approximately 185 by the first of November, 1932. This would be followed by a decline in the market until the summer of 1933, when the market should reach a level of approximately 85 on the Dow-Jones

Index. He further stated he expected that sometime in 1935 the market will reach a level of better than 300.

The next meeting of the Los Angeles Chapter was held August 23, the principal speaker being Dr. Ray B. Westerfield, Professor of Political Economy at Yale University. The subject was "The Necessary Shift in Basic Banking Philosophy." Dr. Westerfield spoke at some length on the very large number of banking failures in this country during the past few years, which he believed was largely due to the existing system of banking. He brought out that when this country was in the pioneer stage of development this system was effective because of the isolation of the various communities, one from another. In recent times, however, the economic structure of our country has passed beyond this pioneer stage and has become more complex.

Because of this complexity it has become impossible for any individual, such as the country banker, to be informed on the proper handling of any financial matters. Also because of the conservative nature of both banking and rural thought, the country banker has not progressed in his practices to meet the needs of his community. It was Dr. Westerfield's belief that these needs of the country are best filled by an organized banking structure, such as the existing system of branch banking. This is evident by the situation in California where, with two large branch banking systems, California has the lowest rate of bank failures of any state in the Union. With such managerial ability as can be brought together by large banks the various problems concerning the operation of the banks may be met most advantageously.

The Pittsburgh Chapter.—Mr. Joseph P. Tufts, Assistant Director of the Pittsburgh Housing Association, gave an interesting discussion at the meeting, on August 25, on the "Probable Effect of the Home Loan Bank Act." There was the lowest attendance of the year, 16, largely due to vacations.

At the September meeting on September 22, Mr. C. R. Texter, Chief of the Bureau of Information for the Greater Pennsylvania Council, gave an interesting discussion on "Population Trends, 1900 to 1930, and Their Effect on Industrial Development." About 35 attended.

United States Bureau of Labor Statistics.—An investigation of the effects of technological changes upon employment in the manufacture of electric light bulbs is now being made by the Bureau. Reports on similar studies for the electric light and power industry, mail transportation, and the leather industry were published in recent issues of the *Monthly Labor Review*.

The field work in connection with studies of wages and hours of labor in the pottery, cement, and lumber industries has been completed, and in the case of the lumber industry the data have been tabulated. Summaries of the information obtained in the surveys of wages and hours of labor in air transportation, the boot and shoe industry, woolen goods manufacturing, the dyeing and finishing of textiles, the tanning industry, and sawmills have been carried in recent issues of the *Labor Review*, as well as a preliminary report on union scales of wages and hours of labor.

The results of the study of the relative cost of material and labor in building construction, which had been in progress for some time, were published in the October *Labor Review*. The data were taken directly from the records of building contractors and cover a total of 204 residential and nonresidential buildings in 15 cities.

Another special study pertaining to the building industry was that of the man-hour activity in the construction of an apartment house in Washington, D. C., the results of which were also published in the October *Labor Review*. This study shows the

amount of work, in terms of man hours, done by each occupation or trade, the duration of work for each class of employees, and the particular periods during which the several classes of employees were actively employed.

During recent months the Bureau has made studies of man-hour productivity in several industries, using as basic data the statistics collected by the Bureau of the Census in the Census of Manufactures for 1929. Two of these, covering blast furnaces and the lumber industry, were published in the August and October issues, respectively, of the *Labor Review*. A similar article covering oil production is now being prepared for publication.

Activities of the Bureau of Agricultural Economics.—A preliminary mimeographed publication entitled "Tentative Estimates of Gross Income from Farm Production, Current Value of Agricultural Capital, and Selected Expenditures, 1909–1931," prepared by the Committee on Farm Income, O. C. Stine, Chairman, L. H. Bean, Secretary, was issued in July, 1932.

Mr. L. H. Bean of the Division of Statistical and Historical Research, prepared in May, 1932, for hearings at Kansas City before the Interstate Commerce Commission, a statement entitled "Facts Relating to the Agricultural Situation." This is composed largely of statistical tables and charts.

A forthcoming publication, prepared by G. B. Thorne and Preston Richards of the Division of Statistical and Historical Research, will have the title, "Factors Affecting Exports of United States Hog Products."

A mimeographed publication, prepared by L. R. Edminster and others in the Foreign Agricultural Service of the Bureau, and released in July, 1932, deals with "Agricultural Price-Supporting Measures in Foreign Countries."

In Senate Resolutions 280 and 281, respectively, both adopted in July, 1932, the Senate requested the United States Department of Agriculture and the Federal Farm Board to investigate the restrictions upon international trade in major agricultural products throughout the world, the measures being taken to protect farm products, and the effect of these restrictions and measures upon the American farmer; also to investigate the economic situation of hog producers, and the way in which proposed plans for farm relief would affect hog producers.

Members of the Bureau have participated in regional agricultural outlook conferences during the year as follows: the Western Outlook Conference, in Salt Lake City, August 11–12; the Central States Outlook Conference, in Chicago, September 14–16; the New England Outlook Conference, in Boston, September 29–30; and the Southern Outlook Conference in Atlanta, November 8–11.

Source Book for the Study of Industrial Profits.—A *Source Book for the Study of Industrial Profits*, containing a series of coded tables presenting financial statistics for certain groups of corporations from 1919 to 1928, has been released by the Department of Commerce. Dr. Ralph C. Epstein of the University of Buffalo prepared the Source Book in collaboration with Florence M. Clark.

The Source Book is designed solely for the use of research economists and expert statisticians, and is not intended as a hand book for reading or reference by the general public.

Its tables, extending over the ten years ending with 1928, show, for each group of corporations, sales, total net income, capitalization, bonded debt, federal income tax, dividends received, inventories, cash dividends, capital assets, patents and good will and frequency distribution of capitalizations.

Only figures for groups of corporations are given, the identity of information on individual corporations being concealed.

Copies of this publication can be obtained from the Marketing Service Division, Bureau of Foreign and Domestic Commerce, for $1.00 a copy. The charge for this is in conformity with the requirements made in recent legislation.

Annual Report of the Social Science Research Council.—Copies of the Annual Report of the Social Science Research Council (230 Park Avenue, New York) are available to individuals on request. The new report appeared in December.

Annual Report of the Federal Reserve Board.—The complete edition of the Annual Report of the Federal Reserve Board for 1931 became available to the public in September, and will be sent without charge upon application to the Secretary of the Board. In addition to the review of the year's financial and industrial developments, released for publication earlier in the year, this edition contains statistical records covering a considerable period of years for Federal reserve bank credit, member and non-member bank credit, money rates, monetary gold stock, money in circulation, and general business conditions.

Pennsylvania Department of Labor and Industry.—Under the provisions of a law enacted by the special legislative session of 1932 on unemployment relief, allocations of a $12,000,000 relief fund to county relief boards are made on the basis of estimates of unemployment prepared by the Department of Labor and Industry. Allotments of a $10,000,000 relief fund provided by the special legislative session of 1931 were made on the same basis. Twenty-two millions of dollars of relief funds have been appropriated by the Pennsylvania Legislature within the last year.

The Department is engaged in a survey to attempt to learn from industry what proportion of the number of workers employed in the peak year of 1928 and 1929 are expected to be re-employed when the production level again reaches 1928–1929 proportions. The survey, of course, will disclose only opinions on the subject, but preliminary returns indicate that employers in many industries have very definite ideas on the subject.

The highly publicized reopening of industrial plants in recent months has led the Department to investigate on its own account the number and extent of plant reopenings with a dual purpose in view: (1) to attempt to measure the actual extent of industrial recovery, and (2) to insure that the reopened plants are immediately inspected for working conditions. Preliminary reports of investigations have disclosed that the importance of the industrial recovery is being overemphasized by the press, and in a surprising number of instances it was discovered that the press reports of plant reopenings were without foundation. Preliminary reports of inspection as to safe working conditions indicate that a factory that has been closed for any considerable length of time is, upon reopening, in need of a thorough inspection to insure that the laws and regulations relating to safety and to the employment of women and children are being observed.

A study of the rate of blood poisoning in compensable industrial accident cases in Pennsylvania over the ten-year period, 1921–1930, shows an average rate of infection in all industries of 5.6 per cent. In five industries the rate of infection was found to exceed one case of blood poisoning in every ten compensable accidents. These five industries are the clothing, hotel and restaurant, leather and rubber, textile and food industries. Over the ten-year period covered by the survey, an increasing rate of infection is shown for all industries except coal mining. The rate of infection for all industries increased from 4.8 per cent in 1921 to 5.8 per cent in 1930.

Centenary of the Royal Statistical Society.—During 1934 the Royal Statistical Society (British) completes the first hundred years of its existence. The anniversary, it is hoped, may be celebrated coincident with a meeting of the International Statistical Institute in London.

A Biological Study at Johns Hopkins University.—A coöperative biometrical investigation of the quantitative relations of the endocrine glands in man, with Dr. Walter Freeman, Pathologist and Director of Laboratories of St. Elizabeth's Hospital, and Professor of Neurology in George Washington University, in charge of the pathological aspects, and Dr. Raymond Pearl, in charge of the biometric aspects of the study, is in progress in the Department of Biology of the School of Hygiene and Public Health of the Johns Hopkins University. The investigation is supported by a grant from the Josiah Macy, Jr., Foundation to the George Washington University Medical School. Miss Marjorie Gooch, Associate in Neurology of George Washington University, has been appointed a Fellow in Biology in the School of Hygiene of the Johns Hopkins University in connection with the project.

The Brookings Institution.—In the field of radio discussion the Institution has been asked by the National Advisory Council on Radio in Education to sponsor a program on current economic and governmental problems, given over a nation-wide network on successive Saturday evenings, beginning November 12. Earlier in the autumn Mr. Henry P. Seideman and Mr. W. F. Willoughby, of the Institute for Government Research, coöperated actively in the "You and Your Government" series of broadcasts presented by the National Advisory Council in coöperation with the American Political Science Association.

The Institute for Government Research, at the request of Governor Winant, has made a general survey of state and local government in New Hampshire, and the report is now in progress. Research projects recently brought to completion by members of the Institute of Economics are as follows: Felix Morley, The Society of Nations; R. R. Kuczynski, Bankers' Profits from German Loans; Harold G. Moulton and Leo Pasvolsky, War Debts and World Prosperity; Charles O. Hardy, Credit Policies of the Federal Reserve System.

Dr. Leverett S. Lyon, on appointment as delegate by the State Department, attended the congress on commercial education which met at London, July 25–30. Leo Pasvolsky, now in Europe engaged in a study of currency and credit conditions, is appointed delegate to the International Chamber of Commerce meetings at Paris in December.

During the summer, Dr. C. O. Hardy, on leave from the Institute of Economics, taught at Ohio State University. Dr. Lewis Meriam, on leave from the Institute for Government Research, conducted courses at the University of Chicago on public administration with special reference to national government.

Personals

Miss Mary van Kleeck, a Vice-President of this Association, presided at the meetings of the Second International Conference of Social Work held in Frankfort-on-Main from July 11 to 14. Miss van Kleeck is also an Associate Director of the International Industrial Relations Institute.

Major P. Granville Edge, O.B.E., has been spending several months in Shanghai, China, organizing a new division of Medical Statistics in the Henry Lester Institute for Medical Research. It is anticipated he will be away about a year.

Dr. John W. Gowen, Associate Member in charge of genetics in the Department of Animal and Plant Pathology of the Rockefeller Institute for Medical Research, is spending a sabbatical year in the Department of Biology of the School of Hygiene and Public Health of the Johns Hopkins University. With Dr. Gowen in Baltimore are his assistants, Dr. Ralph G. Schott and Miss Elizabeth H. Gay.

Miss Emma A. Lundberg is serving as Statistician of the New York State Temporary Emergency Relief Administration.

Trustees of the University of Pennsylvania have announced the election of Dr. Joseph H. Willits, Professor of Industry and Director of the University's Department of Industrial Research, to the Deanship of the Wharton School of Finance and Commerce of the University, succeeding Dr. Emory R. Johnson. Dr. Willits will assume the new office in June, 1933.

Obituary Note

Floy Hotelling, whose studies of causes of birthrate fluctuations were published in part in this Journal for June, 1931, died October 2 of heart disease.

MEMBERS ADDED SINCE SEPTEMBER, 1932

Bisom, Julius, Statistician, State Department of Labor, State Office Building, Albany, N. Y.

Brooks, Edith, Federal Reserve Board, Shoreham Building, Washington, D. C.

Buck, J. Lossing, University of Nanking, 150 Fifth Avenue, New York, N. Y.

Burton, John D., R. H. Macy and Company, 34th Street and Broadway, New York, N. Y.

Crandall, Mary H., Federal Reserve Bank, Reports Department, 33 Liberty Street, New York, N. Y.

Flinn, B. W., Certified Public Accountant, 502 Manufacturers Bank Building, Rockford, Ill.

Gruber, Walter J., Public Utility Security Analyst, Moody's Investors Service, 65 Broadway, New York, N. Y.

Hall, Dr. Francisco A. dos Santos, Instructor, Forestry Statistics, Instituto Superior de Agronomia, Tapada da Ajuda, Lisbon, Portugal.

Henemier, Bertram M., Accounting Department, Watson and White, 149 Broadway, New York, N. Y.

Jackson, Dr. Gordon P., Medical Officer of Health, Department of Public Health, Room 312, City Hall, Toronto, Canada.

Laubenstein, Karl G., 4 Maple Court, Maynard, Mass.

Linders, Dr. Frans J., Professor of Statistics, Royal University of Uppsala, Uppsala, Sweden.

McEnery, William J., Security Analyst, Moody's Investors Service, 65 Broadway, New York, N. Y.

Narajowski, Waclaw, Financial Department, Polish Embassy, 41 Broad Street, New York, N. Y.

Pearson, Dr. Egon S., Senior Lecturer, University College, Gower Street, London, W. C. 1, England.

Robertson, Kathryn J., Committee on the Costs of Medical Care, 910–17th Street, N. W., Washington, D. C.

Rosenthal, Irving, Actuary, Guardian Life Insurance Company, 50 Union Square, New York, N. Y.

Zuchovitz, Sadie, Division of Women in Industry, State Department of Labor, 80 Centre Street, New York, N. Y.

REVIEWS

A Mathematical Reformulation of the General Theory of International Trade, by Theodore Otte Yntema. Chicago: University of Chicago Press. 1932. xii, 120 pp.

Professor Yntema's purpose in this compact volume has not been to reach conclusions on the major problems of international-trade theory which are essentially novel, but rather to restate the existing classical doctrines in mathematical form, insofar as they are capable of such statement, and to reconcile or correct earlier mathematical treatments in the light of his own formulation.

The general orientation and character of the analysis can be indicated in brief compass. The basic proposition is that since in international trade the repercussions of given changes are commonly important, and the changes themselves of substantial magnitude, the traditional approach through the *ceteris paribus*, one-thing-at-a-time assumption, is usually inadequate: the approach through simultaneous equations is more appropriate. Professor Yntema, therefore, proceeds first to determine the conditions and simultaneous equations of equilibrium in international trade in a simplified case, in which only commodities are considered. The conditions which permit equilibrium equations to be set up are the fact that the money value of each export of a commodity from one country equals the money value of the import of the same commodity into some other country (costs of transportation being neglected); and the fact that, in equilibrium, the total value of each country's aggregate exports in a given period equals the total value of its aggregate imports. The type of "equilibrium" at issue thus turns out to be the equilibrium of the balance of payments alone; no real attempt is made to establish the conditions of the underlying (dynamic) equilibrium between productive powers, utilities and "human" costs in the several countries. The demand and supply-cost functions for the commodities entering international trade are taken as given; and the corresponding prices and quantities, together with the elasticities involved, become the units of the mathematical analysis. On this basis, a series of simultaneous equations are set up, which permit the derivation of determinate equilibrium values for the unknown prices and quantities. The chief novelty here is that instead of dealing with *absolute* demand and supply price schedules, Professor Yntema deals with what he calls "fixed-height" schedules, in which the actual values are deflated to terms of a constant monetary situation; and then introduces a compensatory "net monetary factor" to allow for the combined effects of fluctuations in the exchange rates and changes in general price levels. This device has various advantages, especially the clarification it permits of the *relative* movements of sectional price groups; and it makes possible the establishment of equations for international trade which are directly cognate with those which may be simultaneously established for internal trade.

With these basic equilibrium equations set up, Professor Yntema then refines them, and introduces the complexities of actual trade conditions. These complexities are, in chief, costs of transportation (which are properly treated like a commodity demanded jointly with the commodities actually shipped), the in-

visible items, and tariffs and bounties. Their effect is to disturb the previously existing balance of payments, and to lead to the establishment of a new balance with changed heights of schedules and changed equilibrium prices. On the assumption that the changes in spendable funds within the countries concerned, which result from the operation of tariffs or bounties and of the "invisible" payments, are generally distributed, and by starting with extremely small changes, it is then possible to set up differential equations which permit a description of the new equilibrium situations. As before, the equations are stated in terms of money demand and supply schedules; but if some unique simplifying relation be assumed to prevail between money costs and prices and "human" or sacrifice costs and utilities, the transition to the classical doctrine of comparative labor costs is easy.

It is always risky for a non-mathematician to discuss an analysis resting on mathematical methods; he is likely to make stupid and unfair criticisms, and is still more likely to miss the ingenious subtleties which have especially pleased the mathematical author. There are nevertheless certain points to which attention may be called. First, Professor Yntema deliberately assumes that changes in trade conditions which are due to monetary factors shift *all* demand and supply schedules proportionately (pp. 3, 6 ff.). The assumption seems necessary to simplify the analysis, but it is unreal; the one thing which is clear about changes in the quantity of money is that they do *not* affect the different kinds of prices equally or in proportion. Nor is it by any means necessarily true that loans or other unilateral payments even "tend," under present-day conditions, both to increase the quantity of the circulating medium in the country receiving the payments, and to diminish it in the country making them (pp. 27, 61). And surely "constant" monetary conditions should entail stability of the price-times-quantity term, not of the price term alone (p. 5n, ff.). Second, the treatment of decreasing costs seems inadequate (pp. 9, 41 ff.). I have nothing better to suggest, but I am bothered by the apparent failure to recognize possible differences in the shape and even the slope of the cost curves as between foreign and domestic (if any) sources of supply; or to recognize that even if the domestic cost curve is decreasing, the decrease may not be rapid enough to eliminate imports; or even to distinguish clearly in any case between the imported and the domestic parts of the total supply. Third, the attempt to measure the terms of trade in resources-costs (p. 19) seems to me open to much the same objections that apply to the classical measurement in terms of human costs: it is necessary to assume an arbitrarily constant or at least determinate multiplier, to obtain the actually observed money costs. Fourth, the definition of "equilibrium" and its stability not only runs primarily in terms of the balance of payments alone, but is also, when refined, rather confusing to the non-mathematical mind. In the discussion of stability of equilibrium (especially p. 87) it is not clear what is really meant by "stability." The question of the elasticities of supply and demand, which Professor Yntema stresses particularly, would appear to bear not so much on the balance-of-payments equilibrium itself as on that underlying equilibrium of productive powers, purely domestic conditions in relation to international-trade conditions, and the like, which at most points he explicitly disregards.

There are also minor points. The equations on page 28 are correct, but to the laymen seem obscurely explained; on page 34 definition of the term t seems to have been omitted; ignorance impels me to wonder why the elasticity of demand for imports may differ from that for the same commodity produced at home (p. 44) unless—what is hardly permissible—two different kinds of demand are here at issue; the propositions on tariffs and bounties (especially p. 51) are true only if part of the burden or benefit is shifted to the foreigner; and it would have been desirable, in Chapter V, to include some account of the effects of expenditure by the government of receipts from duties (or conversely for bounties). I also confess to remaining unconvinced of the reality of the discussion of elasticities themselves (pp. 43 ff.); but the large controversial literature on this whole question makes brief comment impossible. On the other hand, the analysis of the effects of indemnity payments (especially pp. 91, 92) and indeed the whole treatment of "invisible" transactions, seems to me subtle and enlightening, granted the premises, as does the treatment of trade disturbances in general; and the suggestions on the possible net gains from tariffs is interesting.

Taking the book as a whole, however, the non-mathematician is entitled to ask what its contribution to economic theory consists in, and to require proof that he can understand. Professor Yntema himself disclaims any attempt to formulate substantially new conclusions on major points of doctrine. On the other hand, he has taken the existing conclusions, and with great skill has clothed them in mathematical formulations which are a substantial advance over the work of earlier mathematical writers. How valid and how valuable are these formulations? If we take the accuracy of the mathematics for granted, the answer evidently depends on the stability and indeed the reality of those demand and supply functions, which are the basic elements of the analysis. On this matter, in turn, opinions differ widely, and the present reviewer is inclined to unwilling but grave scepticism. Professor Yntema, by explicitly assuming these functions as given, in a sense begs the question which is fundamental to his whole analysis. If the functions are irrationally variable, instead of unique, then we must disagree with his closing paragraph: it is of no use to establish the general form of relations between variables which are not statistically measurable, and which in the mathematical sense are not unique or determinate elements at all. This of course involves the old controversy over the general applicability of mathematics to economics, or at least to the types of economic data which are now available. Though the non-mathematicians, often unconsciously, use certain essentially mathematical devices over and over for purposes of exposition, I think the burden of proof still lies on the mathematician himself to show that his tools can as yet help in making major additions or improvements in the disordered structure of present-day economic theory. Similarly Professor Yntema's book is a scholarly and highly creditable construction, containing many enlightening refinements and restatements, and will be of great value *provided* its premises can be granted; for the book itself I have only admiration. But I think it still remains to be proved that these premises are sufficiently close approximations to reality to give the edifice which is built on them any large measure of practical validity.

Columbia University JAMES W. ANGELL

The Greenbacks and Resumption of Specie Payments, 1862–1879, by Don. C. Barrett. Harvard Economic Studies, Vol. XXXVI, Cambridge University Press. 1931. x, 259 pp.

In this monograph, Professor Barrett has presented "in monographic form a critical account of the difficulties, the pitfalls, and the outcome of our experiment during the entire greenback period from 1862 to 1879." One chapter in the volume (No. II) was originally published some years ago as an article in the *Quarterly Journal of Economics*, while Chapter III and the early part of Chapter V are based largely upon Mitchell's *History of the Greenbacks*. Other chapters contain original material particularly appertaining to the later history of the paper currency, and to the difficulties attending upon resumption—a relatively less-known phase of the experiment. The form of the book is attractive, the print legible, the proof-reading generally good. Perhaps, however, it may not be over-critical to suggest the desirability of omitting the "p" in "Fort Sumpter."

The greenbacks and their history have been so widely discussed and so generally treated, as if they represented a thoroughly-explored field of monetary research, that it is often supposed there is little or nothing to be added to the reviews of the topic now available. Those who have entertained such a feeling will find themselves agreeably surprised upon perusal of this new monograph, for it furnishes a wealth of heretofore unavailable data carefully collected from contemporary publications, and a careful arrangement of more familiar material which throws its salient elements into much bolder relief than has been the case in many of the earlier discussions. It is thus a useful contribution to American monetary history.

The book is, however, more than a historical monograph; since it turns—as the author himself has observed—a good deal of light upon the difficulties of resumption. This portion of the work might to great advantage be read by those of our contemporary economists who are now urging in much the same terms that were then current, the retention of an inflationary element in the currency as a necessary step toward the attainment, or restoration, of prosperity. It was exactly this controversy which filled the years between 1870 and 1879 and subjected the nation to what Professor Barrett has well called a "decade of debate and delay." As he remarks at one point (p. 167):

> A wave of economic heresy had struck the people [shortly after the close of the Civil War] . . . The fear of contraction was used as a political expedient to catch votes. . . . The greenback movement which took form at this juncture, and the followers of which regarded inflation of the currency as a means of curing all economic ills, found encouragement in crop failures . . . and business troubles.

Both parties vied in their allegiance to inflation; and the panic of 1873 merely added fuel to the flames. Gold exports, bad business, lack of confidence on the part of foreign countries, reduction of foreign trade, and many other factors only too familiar as elements (as history has repeated itself) in the events of the past year or two, speedily followed. It is a gloomy chronicle of unsound public opinion—closed by a fortuitous success in the restoration of technical soundness rather than by any definite demonstration of allegiance to principle that closes the history of Resumption. There is much in this experience that is of large

contemporary value in its teaching, not only as to public finance but likewise with regard to the growth and development of public opinion, regarding financial and monetary questions.

There is some ground for regretting that, after a convincing picture of the harm resulting from our greenback experiment, the author of this monograph should reach a conventional conclusion regarding the ultimate disposal of the legal tender notes. He says:

> Were they a continuous menace to sound currency, or did they constitute a convenient form of currency and a good device for saving the government interest on $34,000,000? The reasonable reply . . . seems to be that, so long as the people were not convinced that the greenbacks must be redeemable in gold, they were a menace; but when, in the course of time, they came to constitute a negligibly small element in our currency as a whole, and their redemption was beyond doubt, they could not be considered inconvenient or dangerous.

Thus our author leaves the greenback question—so far as principles are concerned—about where he took it up.

H. Parker Willis

Columbia University

Short Selling, by J. Edward Meeker. New York: Harper and Brothers. 1932. vii, 271 pp.

In this book Mr. Meeker erects a very elaborate, imposing, and detailed defense for the practice of selling stocks short, but it is not so creditable a piece of work as would be expected from an authority on the subject. Parts of the book are excellent and above criticism, but other parts are not. The historical development of the practice of short selling and the review of the legislation prohibiting and regulating it are well written and interesting. The explanation of what short selling is and how and why it is carried on deserves praise, but when one reads Part IV, "The Case Against Short Selling," one wonders why there is a section with this title when it is devoted almost exclusively to arguments *for* short selling. An impartial study would suggest at least equal treatment of both sides of the case.

Mr. Meeker even goes so far as to disprove his own statements by using actual data! On page 68 one reads:

> Statistical evidence in this regard (see Part VII, subhead "Analysis of 1931 Short Interest Figures") also shows that, as a matter of fact, *the short interest increases more often and to a greater extent when prices are rising*—not when they are falling. This tendency is natural from the standpoint of the short seller's self-interest. Any particular short seller acts in competition with other short sellers. If he thinks that prices are too high, it is from his standpoint safer to *sell stocks short while prices are still rising*, and to cover his short sale when prices are falling. If he waits to sell until the decline begins, and waits to cover until the rebound has started, he is in danger of "missing his market" in both directions. . . . This is the reason why short selling actually stabilizes fluctuations, *since usually the short seller operates against rather than with the prevailing price movements* in the market.[1]

Actually in Part VII, page 140, one reads, "This [data] indicates that when prices rose, *usually the short interest was declining substantially;* [1] . . ." On the same

[1] Italics are the reviewer's.

page one reads, "Consequently these figures support the view that: (1) Rising prices have generally been accompanied by short covering, as shown by a diminishing short interest; . . ." Mr. Meeker flatly contradicts himself and is inconsistent. The data given in the appendix and *his own analysis of it* on page 140 prove exactly the opposite of what he claims is true on page 68. These data are interesting when associated with a statement quoted during the Congressional hearings on short selling, "The 'astute traders' of the economists don't fight the market trend and act as a brake on the top. They wait until it is well over the top, then they get behind and push it down as far and as fast as they can." [1]

Mr. Meeker endeavors to prove that the stocks not subject to short selling crashed harder than those which were subject to short selling. On page 76 one reads, "The chart of unlisted bank stocks and listed shares already cited clearly shows that the market for the former crashed harder than that for the latter, despite the absence of short selling in the first instance and its presence in the second." Listed stocks are subject to more trading which gives them greater liquidity or better marketability. Only part of this trading is attributable to short sellers, so it is not a fair test to compare listed with unlisted securities so far as violent fluctuations are concerned. A better method of approach would be to compare listed securities in which there was a relatively large amount of short selling with listed securities which were subject to little or no short selling. Mr. Meeker's argument comes to this:

> Listed stocks fluctuate less in price than unlisted stocks.
> Listed stocks are subject to short selling while unlisted stocks are not.
> Therefore, short selling causes less fluctuation in price.

This conclusion is qualified in the next sentence, for one reads on page 77, "If in 1929 short selling in the stock market had been more intensive, listed stocks would *presumably* [2] not have risen so high in the summer nor fallen so sharply in the autumn.

Mr. Meeker presents far too good a case for short selling. Short selling is generally regarded as a valuable practice when carried on by trained individual speculators, but it may become dangerous when used by a large pool. The free and open market which the New York Stock Exchange claims to provide really assumes that no pools operate and that all people act individually and independently, for even Mr. Meeker writes,[3] "The 'free and open market' maintained by the Stock Exchange demands, as is made clear in the distribution statement, that 'all stock is free for sale and is held under no syndicate, agreement, or control.'" It is difficult for Mr. Meeker to view short selling from an unbiased standpoint, as this book indicates. The reviewer sincerely hopes that Congress does not pro-

[1] "Short Selling of Securities," Hearing before the Committee on the Judiciary, House of Representatives, Serial 5, Part 1, February 15, 17, 19, 24, 1932. P. 12. The reviewer has made a statistical study of the data on short selling published by the New York Stock Exchange, but the limitations of this review do not permit an adequate presentation of the results. There is no significant correlation between short selling and the index of stock prices over the entire period for which data are available. For short periods the correlation is sometimes positive and sometimes negative, but the correlation is too small for periods sufficiently long to enable one to draw the conclusion that short selling stabilizes price fluctuations.

[2] Italics are the reviewer's.

[3] J. Edward Meeker, *The Work of the Stock Exchange*, p. 101.

hibit short selling without providing some substitute, but he must still maintain that Mr. Meeker's defense of the practice is too enthusiastic and in some degree erroneous.

HARRY PELLE HARTKEMEIER

University of Missouri

New Methods of Measuring Marginal Utility, by Ragnar Frisch. Tübingen: J. C. B. Mohr. 1932. 142 pp.

Dr. Frisch's first statistical attempt to measure utility is based on the records of a Paris coöperative society between June, 1920, and December, 1922. From these are deduced for each month three quantities: the amount of sugar consumed per capita by the membership; income per capita, judged apparently by the total sales of the society, divided by a cost of living index; and a ratio between the price of sugar and the cost of living. A curved surface is fitted, corresponding to an equation among these three variables, which are denoted respectively by x, r and α. This, with the mathematical theory of utility developed, gives the marginal utility of money as a function of income. According to this analysis, the marginal utility w of a deflated dollar is the product of α and the marginal utility $u(x)$ of a pound of sugar when x pounds are used. The equation of the surface is, in fact, $w(r) = \alpha u(x)$. By taking a section, $x =$ constant, of the surface, a relation is obtained giving α, and therefore the marginal utility w, as a function of the real income r. With the happy readiness to mix Greek with Latin which characterizes Scandinavian statisticians who write in English, Dr. Frisch calls this the isoquant method.

In order to use wartime household budget data for graduation of a utility curve, the author adopts two other procedures, which he calls the quantity variation method and the translation method. The former is based on the *quantities* of food purchased in different groups as functions of income; the latter on *expenditures* on food. The translation method is applied to budgetary data gathered in thirteen American cities in 1918–1919, and there results on page 64 a table giving the marginal utility w corresponding to each of twelve levels of real (deflated) income r. When r increases from 2.40 to 6.50 (necessarily arbitrary units) w diminishes from 10.00 to 6.72, while the "flexibility" of the curve, defined as $\frac{d \log w}{d \log r}$, declines from .617 to .261.

These methods proceed from a theoretical basis slightly different from that of the method published by Irving Fisher in 1927, which involved comparison of expenditures by similar families in two places on two commodities. At that time Professor Fisher apparently slipped into a conclusion, based on a criterion of "equality of sacrifice," which to him meant equal decrements of utility, that an income tax ought to be levied with lower rates on the rich than on the poor if the flexibility of the money utility curve should turn out to be less than unity. Dr. Frisch's statistical studies now indicate that the flexibility is actually less than unity, but he does not share Fisher's tacit assumption that the "equal sacrifice" principle is the only one possible. A chapter is devoted to various possible cri-

teria for income tax graduation. Of these, the one which commends itself most is the principle of minimum total sacrifice of F. Y. Edgeworth and T. N. Carver, and this leads to complete equalization of incomes, independently of the form of the utility curve, except as the principle may be modified so as to encourage production.

The chapter on index numbers contains some excellent ideas. A chapter on money utility and the supply curve of labor includes a rebuttal of the argument that a labor supply curve must always slope downward, and a discussion of doles and poll taxes in relation to this curve. At the end of the book, an interview or questionnaire method is suggested for evaluating utility functions.

To the doubts whether utility is objective, the reply may be made that demand and supply functions are objective things, and that if utility is defined as an integral or other functional of these functions, it too is objective. In this sense, utility has the same legitimacy as a physical concept such as work or potential, which is the line integral of force, provided certain integrability conditions are satisfied. The weaknesses of discussions of utility which start on a psychological basis are those of treatments of force which start from muscular exertion. This sort of a start may indeed be excellent, but if an author has too great a horror of equations it leads nowhere, either in physics or in economics.

The statistical evaluation of the functions involved is a difficult matter, and this book, like Professor Fisher's paper of five years ago, is more concerned with telling how to work them out than with showing the numerical results accomplished. But the methodological discussion leaves an important gap in failing to mention the probable errors, which are obviously large. Free-hand smoothing, which the author has used in places, is indeed essentially defective in this respect. In order to carry conviction as to the utility of the utility concept, it will ultimately be necessary, not only to find data for which fairly accurate evaluations can be made, but to demonstrate that these evaluations are accurate. To show that there is real accuracy, free-hand methods can never suffice.

HAROLD HOTELLING

Columbia University

The Street Railway in Massachusetts, by Edward S. Mason. Cambridge: Harvard University Press. 1932. 222 pp.

Amply illustrating many contemporary aspects of the unsolved general problem of privately-owned public utilities, Professor Mason's analysis of the history of the street railway in Massachusetts possesses more than local interest. As was the case with the steam railroad before, and with the electric light and power industry later, the chief spur to the construction and consolidation of electric railways in Massachusetts appears to have been derived from the profits of promotion and the sale of securities. The Massachusetts system of control of the securities issues of public utilities prevented much of the flagrant stock-watering that accompanied the growth of street railways in other states, but its administration was sufficiently lax to make the profits of new flotations attractive to underwriters and distributors of securities. The holding company, moreover,

was early invoked in connection with street railway enterprises, as it has been more latterly in connection with the electric power industry, to loosen the restrictions, in part, of public regulation. Public control was wholly ineffective in keeping the investment in the industry within economically sound limits. So long as investors could be persuaded to buy street railway securities, new lines continued to be built and old ones consolidated, after all other justification for expansion or combination had ceased to exist. The investment attractiveness of such securities was artificially created, maintained, or enhanced by the payment of unduly high dividends, which were made possible by a radical neglect of adequate depreciation charges. There was little attempt on the part of the public authorities to enforce adequate standards in the latter respect.

The qualities of stability, monopoly, and government protection that commonly give high value to the securities of public utility enterprises proved to be largely illusory in the case of the electric railways. Accompanying the rise in the general price level, there was an increase of about 20 per cent in street railway operating costs between 1900 and 1914. The rates of fare, nevertheless, remained largely stationary. Indeed, the effective rate of fare was actually reduced over large areas as the result of the absorption of outlying lines by urban enterprises which extended the distance covered by their standard five-cent fare to their new territories. Most illuminating of the reasons advanced by Professor Mason for the unwillingness of the companies to petition for fare increases during this period was the fact that such petitions would have forced them to disclose their unsatisfactory earnings status, and would thus have impaired their ability, and that of their holding companies, to market securities.

The long-growing difficulties of the street railways were climaxed by the rapid and enormous increases in operating costs during the War and post-war years. Large and small companies went into receivership and hundreds of miles of line were abandoned. Fare increases were now belatedly requested and more belatedly granted, but the demand for street railway transportation proved to be surprisingly elastic, so that higher fares produced disproportionately small increases in revenues. The decade following the end of the War, with its amazing growth in the use of private passenger automobiles and motor busses, sealed the doom of the electric street railway in all but the most populous urban centers.

Professor Mason's attractive style easily carries the burden of detailed exposition, and the import of his study is of broader significance than the monographic character of the subject might suggest. The book contains a considerable body of descriptive statistics, and an excellent analysis and index of street railway operating costs for the period 1900–1925.

LAWRENCE H. SELTZER

College of the City of Detroit

Japan: An Economic and Financial Appraisal, by Harold G. Moulton, with the collaboration of Junichi Ko. Washington: The Brookings Institution. 1931. 645 pp.

The difficulties presented by the Japanese written language have led American and British students of economics to resort to methods of study of Japanese

economic conditions that would not be regarded as permissible in dealing with conditions in a continental European or a South American country. Dr. Moulton's work, however, differs from the average Western study—usually constructed from the extremely limited materials available in Western languages supplemented by observation and interviews—in being based on a very extensive collection of materials translated from Japanese by Dr. Moulton's collaborator. This represents a great advance on previous academic studies in this field. There is, indeed, no adequate reason why in the future our universities and research organizations should not be able to train a certain number of economics students in Oriental languages instead of mechanically insisting that every student concentrate on two European languages. For some time, however, Moulton and Ko's work is likely to remain the best general introductory work in the English language to Japanese economic conditions. It is a comprehensive and well proportioned economic survey of Japan, and supplies a want felt for a long time by American and British students, who are now, with the publication of this and of Dr. and Mrs. Orchard's important, though more specialized study, much better provided with materials than they were before 1930.

Within the limits of a brief review no attempt can profitably be made to describe the contents: every student interested in Japanese economic conditions should discover these at first hand. It will imply no disparagement of the book as a whole if part of the remaining space is taken up with criticisms of a few points of detail.

It is unfortunate that in the descriptive section, which occupies the larger part of the book, detailed references to the Japanese sources utilized by Mr. Ko, apart from the statistical sources, are largely omitted. Japanese titles could easily have been given in romanized form. Some of the tables could have been simplified by the use of significant figures only.

The relative importance of different industries at selected time intervals is estimated on the basis of relative gross values of output and relative numbers of workers. The first of these methods is generally recognized as unsound, and I have tried to show elsewhere that the second cannot be safely applied to Japanese industries, nor do I think that it is logically defensible in any case. A number of writers on Japan have gone astray on this point, possibly owing to vague ideas as to the meaning of relative or comparative "importance." It is the relative contribution of an industry to the national income which properly constitutes its relative importance.

Though Dr. Moulton considers that "on the whole, Japanese statistical methods and data now compare favorably with those of other countries," he has omitted to describe the methods of compilation of primary data given in official sources. In point of fact the lack of censuses of production in Japan places data on quantities and values of production on a far lower plane than similar data for America and England. Moreover, there is no approach to a cost of living index number for Japan.

It is a weakness of this book, considered as an economic survey, that its treatment of agriculture is relatively very brief and conventional. Incidentally, I shall not be alone in dissenting from the view that "to the traveller it appears that

almost every available inch of land is utilised." However, Moulton and Ko are perhaps less at home in agriculture than in industry and finance and may be quite justified in concentrating mainly on the latter. The treatment of public finance and of financial organization is specially valuable.

Notwithstanding the case which Dr. Moulton makes for the return to gold at the pre war parity, I doubt very much whether Mr. Inouye's policy in this matter was wise. In particular the strain placed on agriculture by the deflationist policy was serious, and the political discontents which paved the way for the seizure of power by the militarists were not altogether unconnected with monetary policy.

Lack of space prevents me from quoting Dr. Moulton's important, and, I believe, sound judgment of the results on balance of Japanese economic penetration of China (pp. 470–473), and of his, to my mind, convincing argument that "while the possession of raw materials is undeniably of importance, it is not indispensable to the development of industry." It is to be hoped that what Dr. Moulton has to say on both these points will, when it appears in the Japanese translation by Mr. Ko, receive careful attention in Japan.

E. F. Penrose

Food Research Institute
Stanford University

The Revision of the Price Index Numbers, by T. Sheng. Bulletin of the National Tariff Commission. Ministry of Finance, National Government of the Republic of China, Shanghai. 1931. 30 pp.

In China the art of index numbers has been developing rapidly in recent years. The revision described in this pamphlet marks an important step forward.

The revision was made largely to afford better comparisons than the old index numbers afforded because of differences in the choice of bases and because of badly chosen formulas.

As with many recent revisions of index numbers in other countries, the simple arithmetical average has been abandoned because in comparing two dates it does not work both ways consistently. The fixed base system is used, the base being 1926.

The new formula used is the simple geometric, except for the export and import indexes for which weights are available. The weighted arithmetical is then employed, the weights being the values imported or exported.

The indexes of Wholesale Prices in Shanghai include sub-indexes for cereals, other food products and provisions, textile fibers and manufactures thereof, metals, fuel and lighting, building materials, chemicals and preparations thereof, and miscellaneous, as well as the General Index.

The indexes both of Export Prices and of Import Prices in Shanghai include agricultural products, forest products, mineral products, the average of the preceding three, producers' goods, consumers' goods and a general index.

The resulting figures are of great interest today because China is now the only important country remaining on the silver basis. The ratio of gold to silver

which was 1 to 29 in 1925 fell to 1 to 79 in February, 1931. While gold standard countries have been suffering from a fall in prices since 1929, China "has been seriously affected" by rapidly advancing prices. This is one more evidence of the domination of money over the price level. Those who think otherwise should study this pamphlet. The general wholesale price index for Shanghai rose from 100 in 1926 to 129 in June, 1931 (the latest figure in the table). The index of export prices rose in the same period only to 111.7 while the index of import prices reached 156.1. The general wholesale index of the United States Bureau of Labor Statistics for June, 1931, on 1926 as 100, fell to 70.

IRVING FISHER

Price Sources, U. S. Department of Commerce. Washington, D. C. 1931. 320 pp.

This manual presents an alphabetical list of "commodities," each entry in the list showing the name of a publication giving regular price quotations, the frequency of its publication, and a geographical specification of the market or markets. An appendix gives alphabetically the publications cited, of which there are a few more than 1,000. The publisher and address of each are stated. The manual was compiled from the publications received in the libraries of the Department of Commerce by Elizabeth M. Carmack. The commodity captions employed include both individual commodities and group terms such as "metals," and "grains." Some commodity index numbers are listed. Several of the captions, moreover, do not refer strictly to commodities, e.g. "stocks," "freight rates," "exchange," and "wages." Although foreign quotations are included, the majority of quotations are for American markets. Little attempt is made to give specifications for the quotations. Different grades or conditions of a commodity are often but not always distinguished. Thus there are "potatoes," (unspecified), "sweet-canned," "sweet," etc. "Wheat" is not sub-classified. Although it is not so stated, the quotations may with few exceptions be presumed to be wholesale. Even without any attempt at evaluation of the quotations and in spite of the fact that it will get out of date, the compilation should be useful to statisticians.

MORRIS A. COPELAND

University of Michigan

Commercial Banks, 1913–1929. League of Nations, Economic Intelligence Service, Geneva. (World Peace Foundation, 40 Mt. Vernon Street, Boston, Massachusetts.) 1931. 429 pp.

The Economic Intelligence Service of the League of Nations has recently issued a *Memorandum on Commercial Banks, 1913–1929*, which classifies commercial banking statistics for all countries on a common basis in so far as this is possible. The compilation endeavors to include all banks in each country, and presents statistics for these banks showing both income and balance sheet items.

In almost every country, statistics such as these are watched with unusual interest by students of domestic economic trends. They rank among the more

important economic series, partly because of the important part which banking plays in modern economic life, and, partly, because statistics of banking are more easily gathered and published than other economic series of comparable significance.

The fact that banking figures are important, however, and that they are readily available in a large number of countries has not meant that banking conditions as between different countries could be readily compared. In each country, those figures which are available represent samples covering predominantly the larger banks in the larger cities. The comprehensiveness of the figures, consequently, is always open to question and varies widely from country to country. Commercial banking institutions, also, vary widely in their organization and scope. It is not safe to compare balance sheet aggregates of banks in a country such as the United States where banking is organized primarily on a unit basis with similar aggregates in Great Britain with its handful of huge branch banking organizations, or with those from Germany and the other European countries where there is no such segregation of commercial and investment banking functions as is common in Great Britain and the United States. Finally, the definition and classification of the most significant banking figures vary widely as between countries so that it is frequently impossible to compare items bearing the same caption, even an item as easily defined as "cash on hand," which may consist of actual currency and coin, or may include balances with the central bank, and sometimes actually includes balances on deposit with other commercial banks, and even checks and other credit items in process of collection. The more important items of "capital funds," "deposits," "loans," and "investments" and their significant constituent elements are much more difficult to compare since seemingly slight differences in definition or classification of these items may lead to wide discrepancies in the published totals.

The figures published in the *Memorandum on Commercial Banks, 1913–1929*, do not solve these difficulties. The volume is excellent as a source record of banking statistics for international comparisons. Its discussion of the figures, furthermore, brings out the differences between the various series and the special factors which must be taken into consideration in using them. The nature of the data is still such, however, that this document will prove most useful in facilitating the comparison of various banking series. The validity of the conclusions drawn from such comparisons, on the other hand, continues to be highly questionable and will remain so until the pioneer work done in this volume has borne fruit among the nations where banking statistics are compiled.

WINFIELD W. RIEFLER

Business Statistics, by John R. Riggleman and Ira N. Frisbee. New York and London: McGraw-Hill Book Company, Inc. xix, 707 pp.

This text is distinctive among the recent flood of books on "business" statistics. The first part of 300 pages is an "introduction to statistical methods," amply covering the usual description of collection, tabulation, graphic methods,

averages, index numbers, dispersion, time series and correlation. The second part considers "practical application[s] of statistics in business," having chapters devoted to business forecasting, budgeting, population and purchasing power, production and labor statistics, market analysis, real estate analysis, investment analysis, banking and executive control and management statistics. Appendices are devoted to schedule and questionnaire forms, mechanical aids, drawing and lettering instructions, outline of local commercial and industrial survey, preparation of statistical reports, common logarithms and tables of squares, square roots and reciprocals of numbers to 1000.

Several features distinguish this text. Emphasis is continually placed on the necessity of exercising careful judgment as to the applicability of mathematical techniques which are never fool-proof. Logical analysis is placed on a par with or ahead of technique, as, for instance, in the introduction of correlation, where a coefficient is not mentioned until the nineteenth page. Technical descriptions, such as rules for computing an index number or a method of seasonal variation, are subordinated by the use of small type. Each chapter includes a set of questions and problems; unfortunately most of the questions, after the excellent ones in the introductory chapter, tend, as is usually the case, to be routine review questions rather than thought-provoking. The problems are well-selected and furnish more than sufficient laboratory material. The application chapters (nearly half of the book) are realistic discussions of the problems met in business and economics, and contain a wealth of information concerning source material and guides. They are real text discussions rather than narrow case studies.

There are occasional minor slips of expression and presentation. In the unusually lucid treatment of index numbers (which follows King in omitting all formulas and disregarding the "tests" of good index numbers) no mention is made of link indexes, and no caution is noted concerning the shifting of the base for certain types. The illustration of the calculation of the geometric mean is poorly chosen, as the authors recognize. The correlation discussion, oddly enough, deals only with time series, with no illustration of static correlation (although such is mentioned). The opening six chapters up to "averages" tend to be rather encyclopedic in their meticulous detail; we wonder if the student is here able to assimilate this detail.

The book is markedly characterized by that desirable quality we have been taught to associate with fountain pens, radios, refrigerators and tires, namely, balance; a balance between technique and logic, between mathematics and usefulness, between methods and application. In the latter half, emphasis is put on meaningful results. We would change the title to economic statistics, as the viewpoint is usually broader than that of the business man. The graphic work, typography and general set-up are unexcelled. The book gives evidence of the care exercised in putting it through five mimeographed editions, each put to the practical test of the classroom.

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Corn and Hog Surplus of the Corn Belt, by Alonzo E. Taylor. Stanford University, Food Research Institute. 1932. 658 pp.

The problem of the corn and hog surplus which is discussed at length in this book is of great interest at this time. The corn crop in 1932 was the largest since 1925 and hog production is increasing. Prices of both commodities during 1932 were the lowest in more than thirty years.

The author divides his book into two parts. Part I contains a detailed discussion of the nature, extent and consequences of a surplus of corn and hogs. The major topics covered in this section are: (1) The production and disposition of corn and hogs in the United States; (2) exports of corn and hog products and the influence of international factors on prices of corn and hogs; (3) the general attitude of Corn Belt farmers and farm leaders with respect to the major economic difficulties confronting Corn Belt agriculture and their causes. Part II deals with the ameliorations of the consequences of a surplus of corn and hogs. The author discusses the various proposed relief measures and how they would probably affect the financial returns to corn and hog producers.

The elements in the corn and hog situation and the general conclusions upon which the author places greatest emphasis may be summarized as follows:

1. The hog surplus, which is considered roughly as the volume of hog products exported, is expected to continue. It will not disappear as did the surplus of cattle and sheep.

2. Most of the hog surplus is in the form of lard. Lard has no distinguishing physical or chemical qualities and is therefore exposed to severe competition from vegetable and marine fats and oils, the production of which has increased greatly in recent years. "The Corn Belt farmer can not be considered as a low cost producer of fat nor is the fat he produces of exceptional qualities." The foreign outlet for both lard and pork probably will become more restricted in future years.

3. Prices of both corn and hogs in this country are determined largely by domestic conditions and not by foreign supply and demand conditions of these commodities.

4. The equalization fee probably would raise hog prices for one or two years if expertly managed, but since hog production could not be controlled the plan would not work for a longer period of time.

5. The export debenture plan is inapplicable to hogs because of the many forms in which hog products are merchandised. Even though it should stimulate prices initially, the higher prices would cause increased production and eventual failure of the plan.

6. The farm allotment plan (as proposed originally by Spillman and Black) is not applicable to corn and hogs.

7. "Internal" methods of relief, which include technical improvements, larger farms, a better utilization of the land and the adjustment of supply to demand, offer considerable opportunity for improving the economic position of Corn Belt farmers.

Many of the conclusions presented represent valuable contributions to the solution of the corn and hog surplus problem, but the author's position with reference to the lard situation, and the theory involved in the determination of

probable immediate results from controlling the exportable surplus, are two major considerations in his analysis which are open to question.

The author's position with respect to the lard situation seems unduly pessimistic. His contention that lard is merely one fat of many, that it has no distinguishing characteristics, and that it will continue to lose favor among consumers, is contrary to the conclusions reached by many authorities who have made studies of the qualities of lard. The shortening qualities of lard are quite generally recognized by researchers and by the trade as being superior to those of the competitive oils and fats, not only in Europe but in this country as well. A study of consumption and prices of lard and lard substitutes during the post-war period indicates that the competitive position of lard has weakened somewhat, but not to the extent that the author suggests. Domestic consumption of lard substitutes has been fairly stable since 1925, whereas lard consumption has trended upward. Lard continues to command a premium over most lard substitutes and in European markets American lard sells at a higher level than the lard from other sources. Without doubt, the advancement in technological processes during the last decade has greatly enhanced the competitive position of vegetable and marine fats, but the opportunity to improve quality and demand through further improvements in manufacturing technique appears to be about as great for lard as for other fats and oils. The author admits that during the last decade the lard export trade has been "surprisingly maintained." Exports to Germany have declined during this period, but this has been due largely to increased lard production in that country. The stability of lard exports to United Kingdom has been due largely to the superior quality of American lard and the assurance of a uniform and adequate supply. Considering these elements in the lard situation, Dr. Taylor's evidence in support of his views of the present and prospective economic position of lard is not convincing.

In setting up the hypothesis involved in his appraisal of the various proposed relief measures with reference to selling larger quantities abroad, the author states that "so long as the fraction of the crop consumed at home is large contrasted with the fraction passing to export, the gain to producers on the total merchandised crop would be larger than the loss sustained on the exports." To consider in this connection only the relation of the amount consumed at home to the quantity exported appears inadequate, since the total net returns to be obtained from controlling the exportable surplus depends in part upon the difference in the elasticity of demand for hog products in this country and abroad. It is conceivable that producers might lose from operations involving the withdrawal of supplies from domestic markets to sell on foreign markets, if the demand were very inelastic abroad and relatively elastic at home, even though most of the crop is consumed at home. The demand elasticities may be such as to make the author's statement entirely correct, but the reviewer failed to find any reference to this phase of the problem.

The author's conclusions are based largely on direct interpretation of a vast amount of basic data, supplemented with the results of statistical studies of other research workers. While the lack of well defined organization and the overlap-

ping of subject matter detract from the general usefulness of the book, to the student of the problem it supplies a fruitful source of facts and a comprehensive discussion of the major problems facing the corn and hog industries.

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Die Agrarkrise in den Vereinigten Staaten, by Julian Gumperz. Veröffentlichungen der Frankfurter Gesellschaft für Konjunkturforschung. Leipzig: Herausgegeben von Dr. Eugen Altschul. N. F., Heft 2. 1931. 182 pp.

The book by Gumperz belongs to a series of publications of the Frankfurter Society on the study of conjuncture. This Society has published during the last three years several interesting studies, mostly methodological in character, relating particularly to the quantitative analysis of the business cycle.

The present study differs from the previous publications of the Frankfurter Society. It is not primarily methodological. Its subject is the analysis of a concrete economic problem: the causes of the present agricultural crisis in America. It attempts also to give a general theory of capitalistic agricultural crises, considering the present crisis in America as a typical phenomenon exemplifying future development in other countries. The book is divided into two unequal parts: the first (only 27 pages) treats the general theory of capitalistic agricultural crises. The second (much larger) presents in some detail an analysis and a theoretical explanation of the post-war agricultural crisis in the United States. The first part is too short to present a well developed theory of agricultural crises, and is limited only to a theoretical outline based on Marxian economic theory. The Marxian law of value, according to Dr. Gumperz, includes all the elements necessary for a total explanation of the social-economic organism and its movements; and Marx's theory of industrial crises furnishes the material for a theory of agricultural crises. We should welcome the position of Gumperz that a theory of economic cycles should explain both industrial and agricultural fluctuations.

I have tried to emphasize the rôle of agricultural fluctuations in the business cycle. Gumperz is not satisfied with my theory because he does not believe that it serves as an explanation of agricultural crises. It was not my purpose to explain them but to distinguish between the short-term fluctuations of agricultural production, with which business cycles are in some way connected, and agricultural crises occurring comparatively seldom, connected presumably with so-called long cycles. Gumperz does not pay enough attention to this distinction, though it is of great importance. If Gumperz would proceed from a simple scheme of a theory of cycles to a developed and complete theory, he would meet difficulties in including in the same theory the phenomena of frequently recurring business cycles and those of agricultural crises occurring but seldom. He recognizes that in the past agricultural crises were not periodic (p. 21); but he believes that in the future, because of a greater inter-connection between agriculture and industry, fluctuations of agriculture will correspond more closely to the phases of the industrial cycle. It may be true, but the phenomenon which is generally called

an agricultural crisis and which we are now observing throughout the whole world is one which occurs seldom rather than frequently. During the more than a hundred years since the Napoleonic wars, there were, perhaps, only three world-wide agricultural crises and they were associated with long periods of falling prices and not with short-term business cycles.

Gumperz rejects the monetary explanation of agricultural crises and in his analysis of the crisis in America, he does not even mention that factor. I fail to see, however, how the monetary factor can be disregarded in the analysis of the present crisis in America. He does not attribute much importance to the post-war condition of the world market. He says that the forces and tendencies acting upon the world market merely intensify and accentuate the difficulties which would exist even without the influence of that factor. The explanation of the crises he finds in the revolutionary changes that have taken place in agricultural technique which require a corresponding reorganization of agricultural enterprises. The crisis in American agriculture, he attributes to the crisis of small-scale farming, not sufficiently capitalistic in its struggle with newly created large capitalistic farms supplied with modern machinery. Gumperz even goes so far as to state in one place that for giant farms (Rissenbetriebe) there is no agricultural crisis (p. 156). The author is too categorical in his conclusions as to the advantages of very large enterprises in agriculture. The benefits of large-scale (giant) farming in some lines of agriculture (such as extensive small-grain farming in semi-arid regions) give him the basis for generalizing for all branches of farming. The problems about which agricultural specialists in this country are still in doubt he solves categorically in favor of the "agricultural factory." His outlook, therefore, concerning the future of family farms in America is too pessimistic. He sees no salvation for independent farmers in this country. They must become proletarians. In one place, Gumperz risks giving an even more concrete forecast by saying that if no modifying tendencies appear, three quarters of the existing independent family farms will have to disappear in some two decades (pp. 160–161).

Gumperz's study often leaves one with the impression that his conclusions are based upon the Marxian scheme rather than upon objective statistical evidences. For this reason the book may give a biased idea about the actual agricultural evolution in America, at least for foreign readers who have no means of verifying the conclusions of the author by personal impressions and observations.

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